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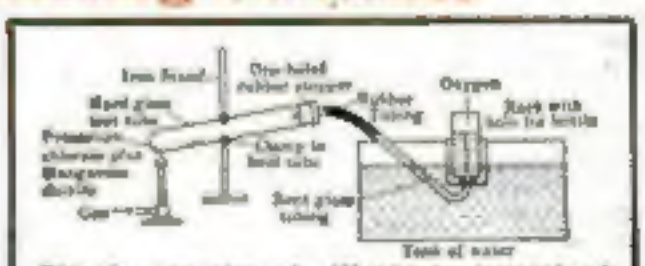

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POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 144 NO. 1

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

CONTENTS for JANUARY, 1944

Cover: Kodachrome by Hans Groenhoff

News

Automobiles

Home and Workshop

OUR NEW PRICE

BEGINNING with the February issue, your copy of POPULAR SCIENCE (if you buy it on the newsstand) will cost you 25 cents. This new price is made necessary by greatly increased costs of printing and paper. At the same time, however, we are giving our readers greater value than ever before through the extensive use of color. Starting with the present issue, POPULAR SCIENCE will contain many pages of color photographs and paintings, in a high quality of reproduction that makes them just perfect for pin-ups and for framing. See this new feature on pages 73-96.

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Yearly subscriptions in United States and its possessions, $2.50; Canada, $3.50; foreign countries, excepting Canada, $3.00. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address.

Coming Next Month

WHAT ABOUT GLIDERS? As a war weapon, are they just a substitute for planes, or can they do things that powered aircraft can't? How does the military glider differ from the peacetime sailplane in construction and handling? Alden P. Armagnac answers all the questions you have been asking yourself about this brand-new tool of warfare.

BURMA isn't all temple bells and romantic native maidens, according to American flyers who have been forced down among its dense jungles and inhospitable inhabitants. An interview with Col. Robert L. Scott, Jr., gives the low-down on the Road to Mandalay as it looks from a cockpit and an escape 'chute. Required reading for future members of Asiatic expeditionary forces.

A VOLTMETER is the only instrument you need for giving your car's electrical system a thorough check-up. Troubles that crop up in battery, ignition, or lights can be diagnosed easily with simple tests described by Ralph Rogers in an article that should find a place in your file of automotive reference material.

SOFTIES! That's what our young men are when they go up for induction, the officers in charge of the Army's physical-training program say. Turning these victims of easy living into tough fighters is the work of a streamlined conditioning course that crams months into weeks in preparing our soldiers for the rough-and-tumble business of modern war.

NO POSTWAR UNEMPLOYMENT looms ahead of the jeep, to judge by the flood of entries in our recent contest. We asked for suggestions on peacetime work for the bouncing buggies—and we got them! Next month we'll announce the names of the winners, with a word-and-picture digest of the ideas submitted.

CALLING THE PLUMBER for every little trouble can be an expensive proposition—and unpatriotic, too, in these days of scarce manpower. With a little knowledge, you can not only make the minor repairs yourself, but also forestall trouble in many cases by preventive measures. John Modroch tells you how to keep your pipes and drains working right.

THE SEARCH THAT NEVER ENDS

IN THE industrial life of America, research has been of constantly increasing importance. And today it is a national resource, for the research of industrial and college laboratories is proving its value in War.

To the Bell System, research is an old idea, for the telephone itself was born in a laboratory. Behind its invention, sixty-nine years ago, were researches in electricity and acoustics and in speech and hearing.

And, ever since, there has been a laboratory where scientists have searched to know more about these subjects; and with their associated engineers have applied the new knowledge, fitting it with all the old, to make the telephone better and better.

Their fields of inquiry have broadened and deepened through these years; they inquire into all the sciences and engineering arts which have any promise of improving the telephone. Much has been learned but still more will be, because their search goes on. That is why the telephone laboratory grew to be Bell Telephone Laboratories, Incorporated, the largest industrial laboratory in the world. And it exists to improve telephone service.

Improvements in industry can be left to chance in the hope that some one, sometime, will think of something useful; that some good invention will turn up.

The other way to make improvements is to organize so that new knowledge shall always be coming from researches in the fundamental sciences and engineering arts on which the business is based. From that steady stream will arise inventions, new methods, and improved products.

This is the way of Bell Laboratories. Its search will never end. And as fast as it can the Laboratories will apply its new knowledge practically to the design of equipment and communication systems.

At present—and this started before Pearl Harbor—its trained scientists and engineers and all their skilled associates are concentrating on products of importance to our armed forces. But when this work is happily over they will be ready to continue their developments for the needs of peace.

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- ★ Battling the U-Boats!
- ★ Russia's Might Astounds World!
- ★ MacArthur's Smashing Offensives!

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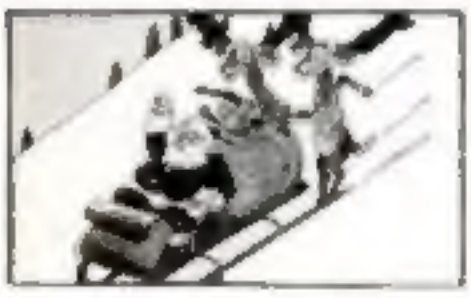

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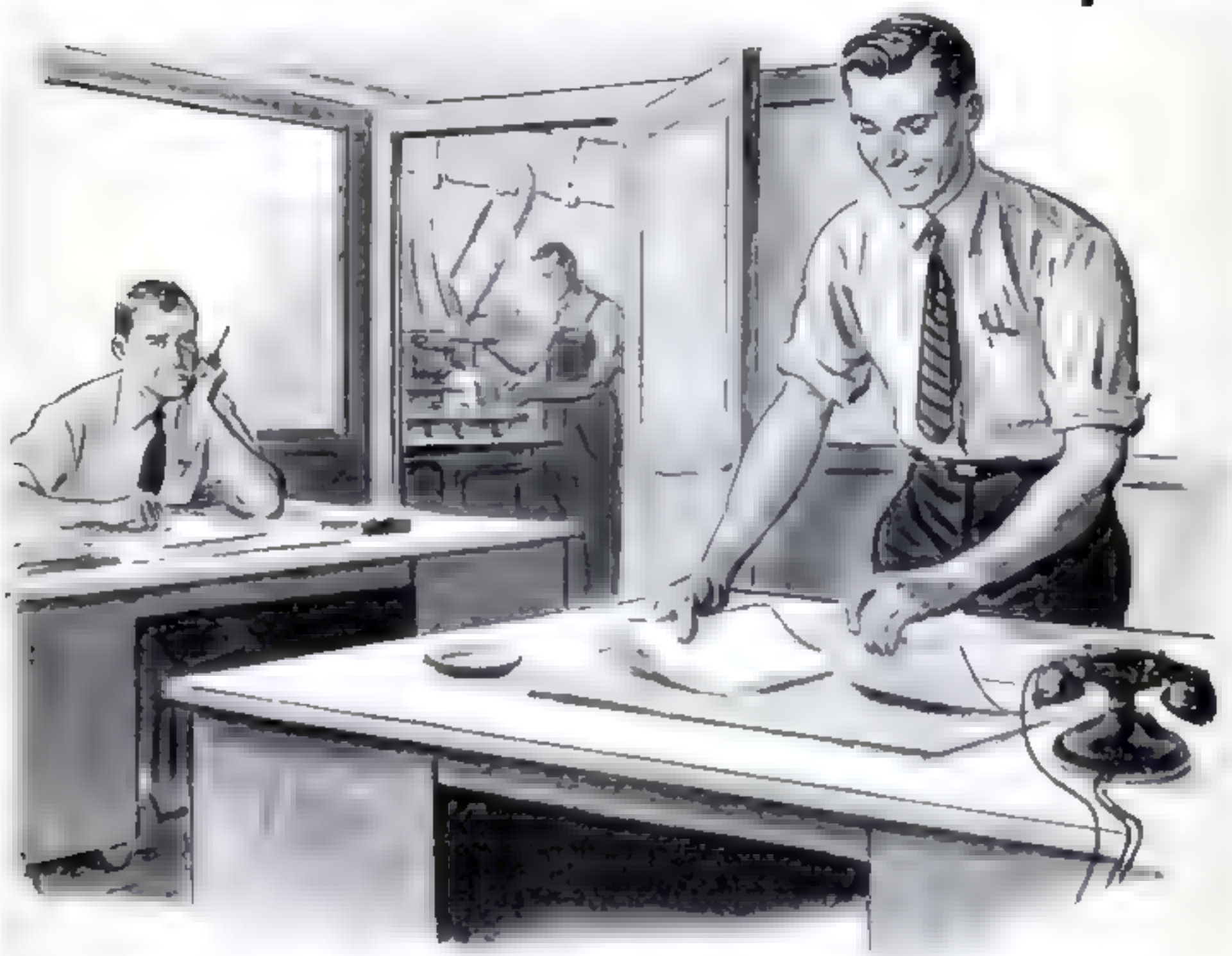

You remember the day Vince Benedict started in Factory Office. You remember his early weeks when *you* "broke him in." Today he's clearing off the old desk and moving into a job ahead of yours. You've been ten years longer with the company and you can't understand it.

Do some realistic checking up and you'll find that Benedict has been *training* himself for the demands and responsibilities of larger positions. It isn't too late for *you* to do the same by taking an I. C. S. Shop Practice Course.

Thousands of successful Americans have acquired their all-important Shop Practice training from the world-famous International Correspondence Schools. The man who has moved around you quite possibly sent in this coupon once. *And it wouldn't be surprising if the man who employs you both is a former I. C. S. student.* Many employers are.

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Broadcasting Stations, Aviation and Police Radio, and other Radio branches are now looking for Operators and Technicians. Radio manufacturers now working on Government orders for Radio equipment employ trained men. The Government alone needs hundreds of competent civilian and enlisted Radio men and women. You may never get a better chance. Now it will be so easy to get started in this fascinating field.

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$200 a month in own business

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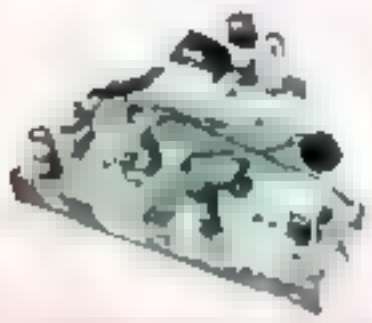
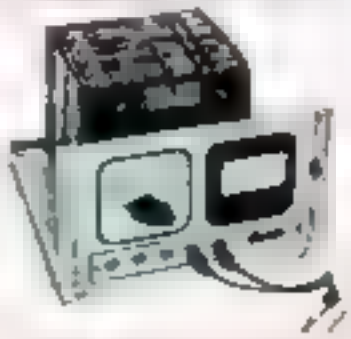
You Build These and Other Radio Circuits with 6 Big Kits I Send!



MEASURING INSTRUMENT: Learn how you build and use it. Use it in practical Radio work to make EXTRA money. You make the meter. It measures A.C., D.C. and R.F. volts, D.C. current, resistance, receiver output.

A. M. SIGNAL GENERATOR (above): Build it yourself. Provides amplitude modulated signals for test and experimental purposes. Gives valuable practice.



SUPERHETERODYNE CIRCUIT (above): Preselector, oscillator-mixer-first detector, I.F. stage, diode detector-A.V.C. stage, audio stage. Bring in local and distant stations on this circuit you build yourself!

By the time you've conducted 60 sets of Experiments with Radio Parts I supply, have made hundreds of measurements and adjustments, you'll have valuable PRACTICAL Radio experience for a good full or part time Radio job!

FIND OUT ABOUT THIS TESTED WAY

Technician

Than Ever Before . . .

Many Beginners Soon Make $5, $10 a Week EXTRA in Spare Time

Right now, probably in your neighborhood, **there's room for** more spare and **full** time Radio Technicians. **Many N.R.I.** students make **$5, $10 a** week EXTRA in spare time **fixing Radios** just as I train **while** learning. I send EXTRA **MONEY JOB SHEETS** that **tell how to do it!**

My **50-50 Method"—half** by reading and **testing real** Radio Circuits, **half** learning **from easy-to-**understand lessons—is **to** learn Radio at home in spare time. Then how much practical experience you get **by** building the **Superhet*** and Measuring Instrument shown at left, as directed, for conducting 60 sets of experiments on these and other Circuits you build with parts I send. Within **a few** months you can be ready to **start your own Spare Time Shop**, or be a Radio **Expert** in a good **job** with a Broadcasting station, a Radio manufacturer or a Government department. Many of your friends and neighbors **get paid while** learning.

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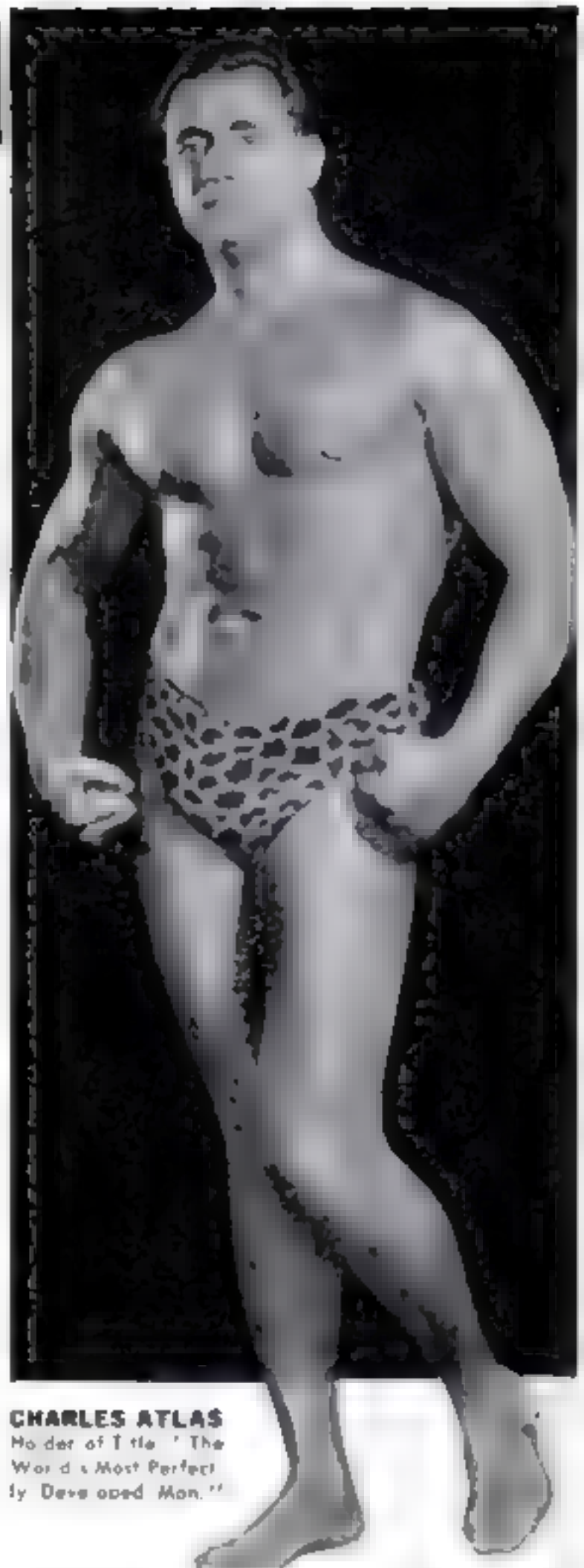

I KNOW, myself, what it means to have the kind of body that people pity! Of course, you wouldn't know it to look at me now, but I was once a skinny weakling who weighed only 97 lbs.! I was ashamed to strip for sports or undress for a swim. I was such a poor specimen of physical development that I was constantly self-conscious and embarrassed. And I felt only HALF-ALIVE

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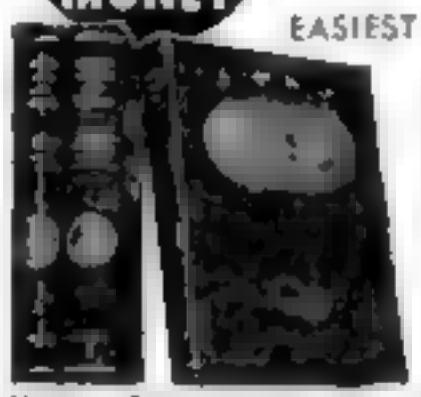

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Our "Patent Guide for the Inventor" answers many important questions concerning Patents that inventors constantly ask. It tells what facts, details, drawings, sketches, etc are necessary to apply for a Patent; how to protect your invention through dated and witnessed disclosure; how to do this AT ONCE to safeguard your rights; how Patent Office Records can be checked to determine whether the invention is probably patentable before filing fees need be paid; discusses costs involved and a practical way these can be paid as the application progresses. It tells how some inventors secured financial backing; how many simple inventions have proved large commercial successes; how Patents covering improvements also can be profitably utilized and marketed; tells countless other facts of interest.

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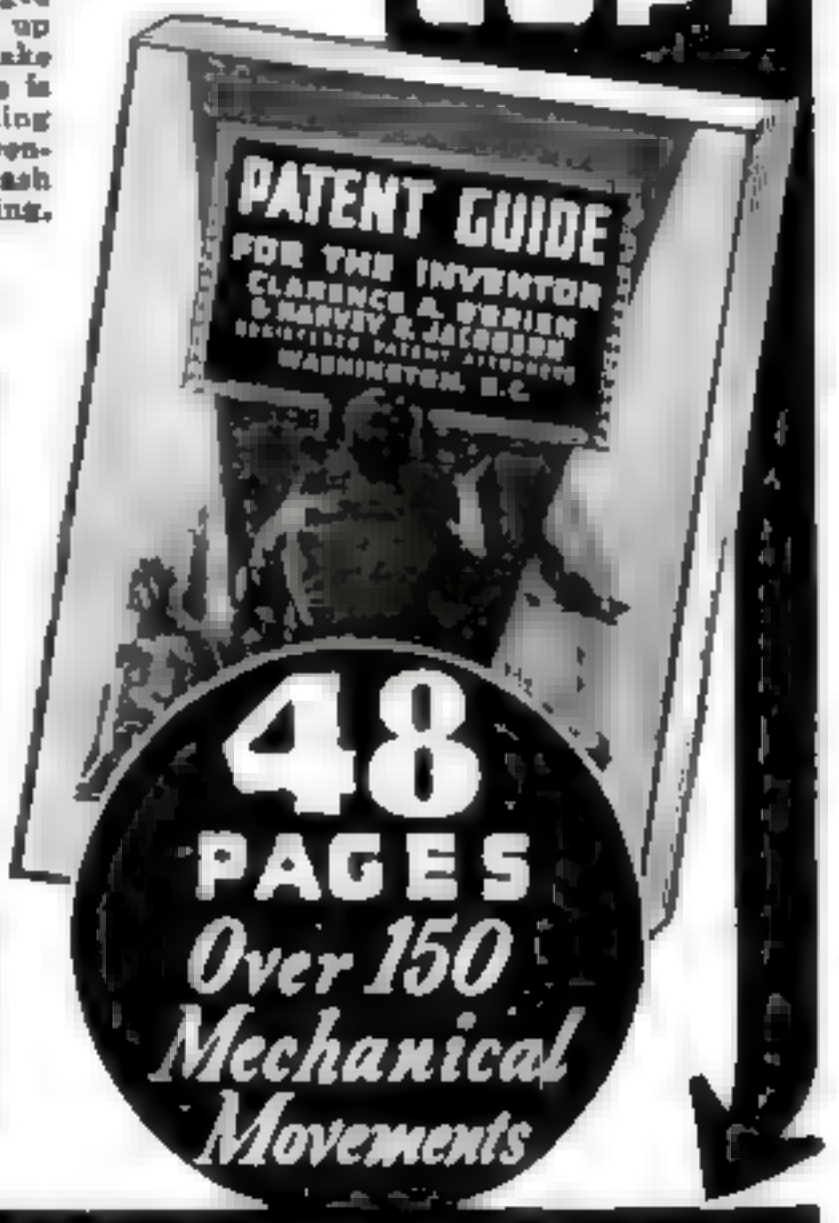

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Readers Say:

height by 1.225 (the approximate square root of 1.5) and you get 24.500 miles. That's some distance to be able to see.—W. H., Cranbrook, B. C., Canada.

To clear up any possible ambiguity, allow us to explain that the distance of the visible horizon in miles is the square root of the product of 1.5 times the height of the eye in feet.—Ed

The Visibility Was Limited When We Checked This

In the quiz on page 92 of your November issue, you ask what "CAVU" means as a weather symbol. The answer you give on page 94 is incorrect—unless the weather officers of the A. A. F. have been giving out false information. "CAVU" means ceiling and visibility unlimited, and not clouds and vapor unsafe, as you have indicated.—Lt. D. T., Selman Field, Monroe, La.

Wanna Blow an Ocarina No One Can Hear?

Here is a contribution that can be extremely useful. It is possible for an ocarina to be played without disturbing anyone. How, you ask? Simply by playing it inside a felt hat. Opposite edges of the brim are held together with a safety pin. Next, the ocarina is placed inside the hat. Then the hands go into the openings. As for the mouthpiece, the most favorable method is to let it protrude through a hole made in the top of the hat. I tested this arrangement with a soprano in G, and the loudest tones were almost completely blotted out. Any old felt hat should be large enough for most ocarinas.—R. J., Elgin, Ill.

Would Anyone Care to Tell Him How?

I would be very grateful if you or one of your readers would explain the process by which passes, identification cards, and other similar documents are coated with celluloid. I have several important papers that I would like to fix up in this manner. Is the celluloid likely to injure the papers, and, if so, how may this best be avoided?—J. F. McGarry, New York, N. Y.

Allow Us to Simplify a Simple Formula

Just received my November copy of P. S. M. and had quite a shock when I read what was supposed to be my letter to you with the formula for determining the distance of the visible horizon. Just try working out the formula for yourself and see how whoever was intrusted to print it got it all twisted. The formula I sent you was: Any intelligent officer of a ship knows that the square root of 1.5 times the height of his eye in feet is the distance from him in miles of the visible horizon. As printed in your Readers Say column, however, the formula would sure give a long distance to the horizon if a man was flying at 20,000 feet. Multiply that

Mystery Cartoonist Exposed as a Clever Guy

Who is the guy that draws the cartoons for Readers Say? He's pretty darn clever. How about more of them? Your Readers Say column is the first thing I read when my issue arrives, and again I say, "Congratulations to you, mystery-man cartoonist."—W. C., Baltimore, Md.

B. G. Seielstad is the man you're looking for. He also has a serious side—as you will note from his drawings which appear frequently in other sections of the magazine.—Ed.

Readers Say:

This Homemade Rifle Is A "Chuck-Hunter's Dream"

PERHAPS you will be interested in this photograph of a gun whose barrel was fashioned from an old truck axle that had been lying around in the sun for eight years. Designed by Chief Petty Officer Raphael G. Moss, shown holding the gun, the barrel was drilled and rifled by P. O. Ackley, gunsmith at the U. S. Arsenal at Ogden, Utah, who did the job in his basement shop. This .22 caliber gun is known as a "Varminter," and is said to be a "chuck-hunter's dream." It fires a .25 caliber shell that has been necked down to accommodate a .22 caliber jacketed bullet. With a heavy powder load behind it, the slug can attain a muzzle velocity of 4,000 feet per second, which is approximately twice as fast as the speed of a regulation Army bullet. With the exception of the barrel, the gun is a regulation Model 70 Winchester, and carries an eight-power scope.—D. H. M., Brigham City, Utah.

Doctor and Soldier Prescribe More of the Same

THE ARTICLE entitled "What Do You Know About Your Ears?" that appeared in your November issue interested me greatly. The text is excellently written and most accurate. The drawings are good enough to be in a medical textbook. May I suggest that more articles of this nature would be most interesting to your readers, including myself.—Dr. E. H., Newport News, Va.

YOUR recent article on the human ear was most enlightening. It should prove helpful to flyers, for ear troubles are a constant danger to them. I have never before seen such clear-cut sectional drawings of the inner ear and its parts.—Pvt. M. K., Army Air Forces, San Bernadino, Calif.

Look in a Mirror and You'll See

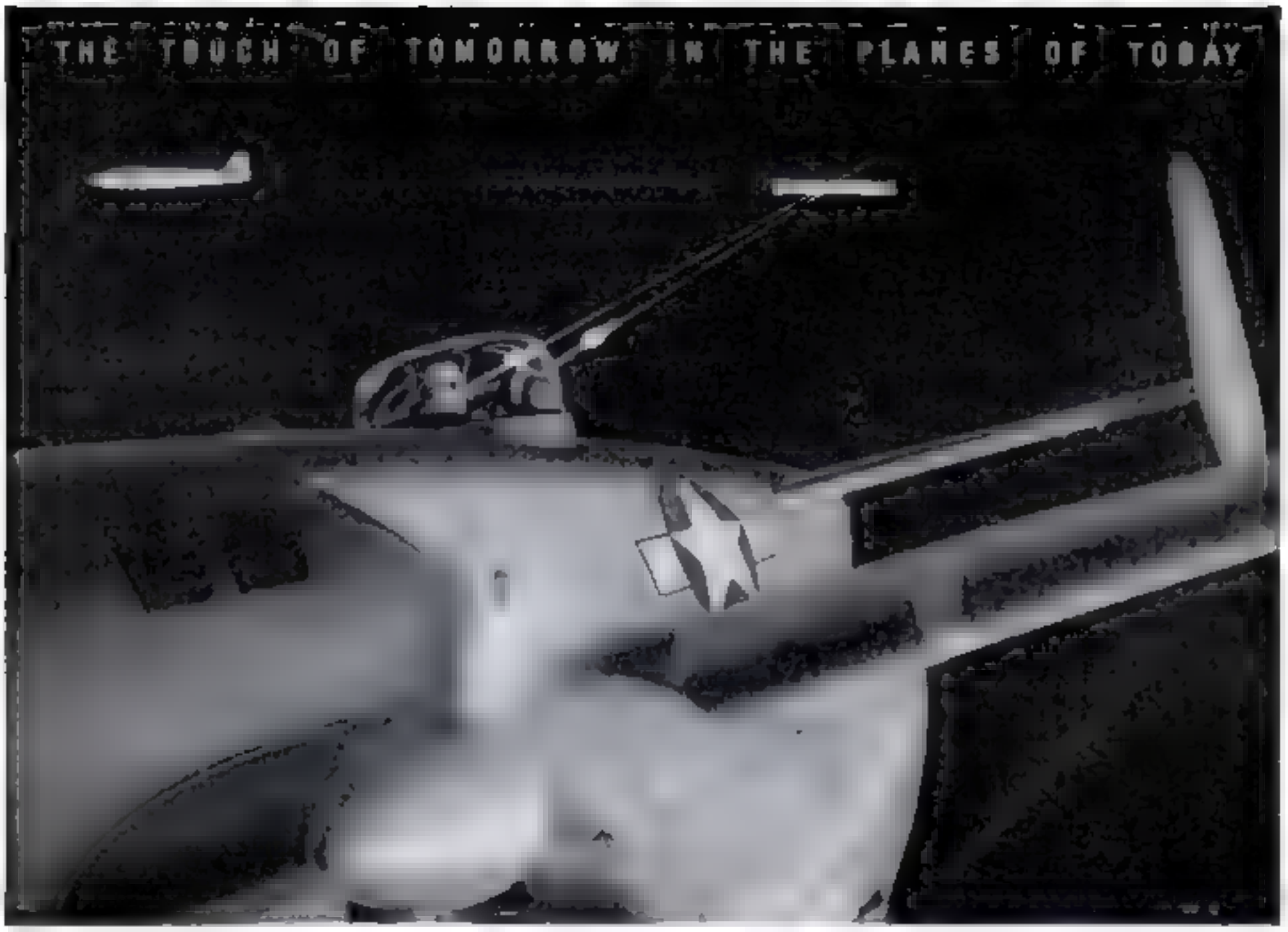
DID YOU know that no matter how hard you try, you can't by watching in a mirror, see your own eyes move?

Even if you turn them only slightly, you can never catch them in the act of moving. A person standing beside you and looking in the mirror, however, can easily see the movement of your eyes. From these and other facts it has been concluded that the eye does not see when it is moving—that it is absolutely blind during the instant it is changing its focus—A. W., New York, N. Y.

A. W. has overlooked the fact that he naturally can't see his own eyes in a mirror until he is looking directly at their image in the glass.—Ed.

His Dad Developed the First Successful Airplane Engine

MY ATTENTION has been called to a letter in the Readers Say column of your September issue concerning an article that you published some time ago on early airplane engines. The data given in that letter regarding the engine built by the late Charles M. Manly is substantially correct. This engine has been acknowledged by not only the Smithsonian Institution but by other eminent authorities, such as Charles L. Lawrence, as the first successful airplane engine. In fact, in 1930 the Langley medal, awarded only seven times for extreme achievement in the field of aviation, was awarded posthumously to Charles M. Manly. I, as the eldest son, was given the high honor of receiving the medal in my father's name. The engine developed by my father is on exhibit at the National Museum in Washington—C. W. M., Staff Engineer, Pan American Airways, Miami, Fla.



It All Adds Up To Subtracting Zeros

Today's apprentice gunner enters a deadly trade—defending American bombers against vicious attacks of Jap Zeros and other heavily armed enemy fighters.

To follow his trade and survive, the gunner first has to learn how to "polish 'em off around the clock." His training must be thorough and painstaking, and it must come within a hair's breadth of being the real thing. That's why Fairchild developed the GUNNER.

This advanced trainer has the essential characteristics of the bombers from which our student marksmen will soon shoot it out with Axis pursuits. From a power turret, similar to one on a Flying Fortress, each fledgling is taught to pick off tiny targets while moving at better than 200 miles per hour. It's fast, tricky work and it takes a keen eye, steady nerves, precision equipment. It's the kind of training that pays off when the chips are down.

Fairchild's GUNNER, from which apprentice marksmen will step into bombers and then into action, is one of the largest, speediest training planes ordered by the Army Air Forces. Powered by two 12-cylinder, inverted, in-line, air-cooled Ranger engines, the GUNNER is a typical example of Fairchild's "touch of tomorrow in the planes of today."

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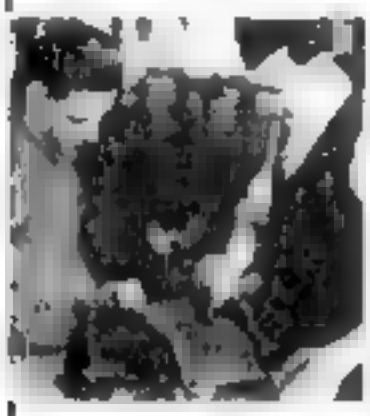

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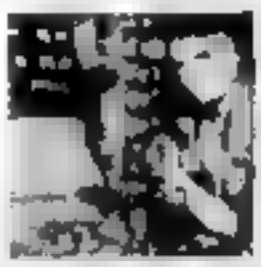

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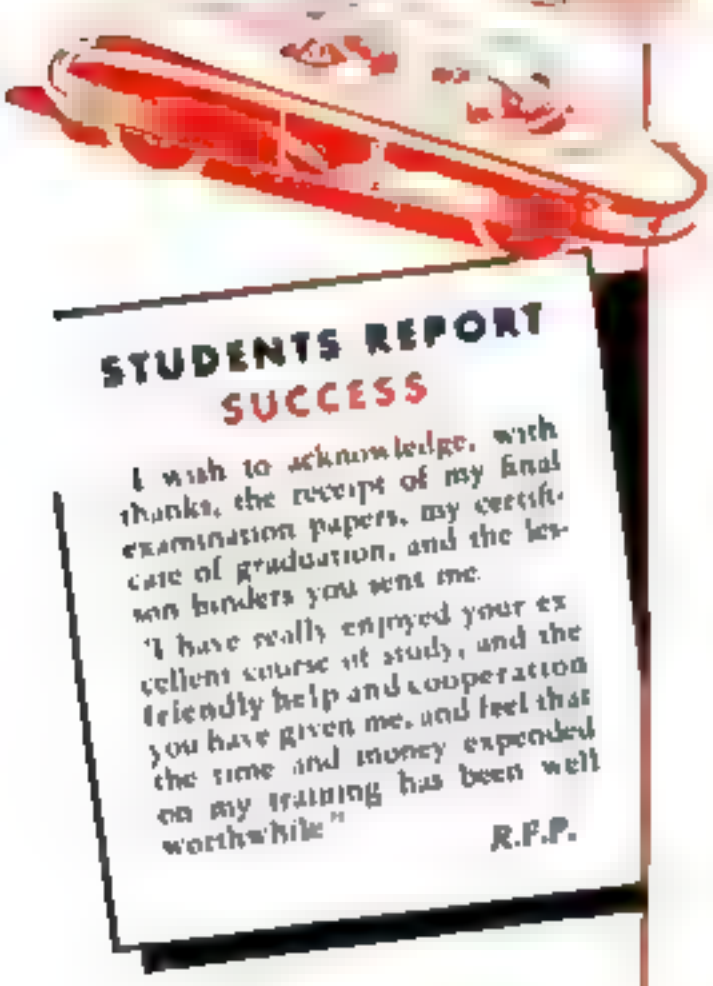

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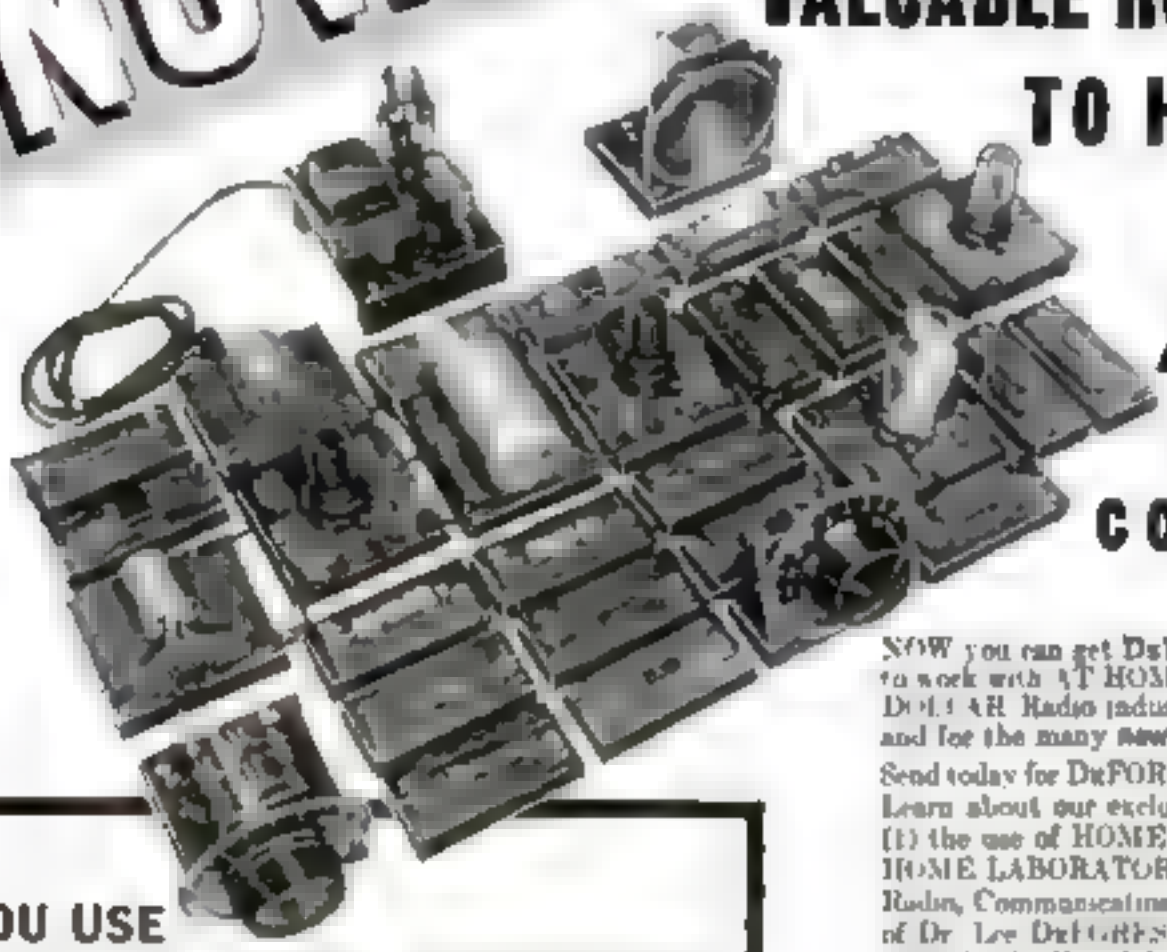

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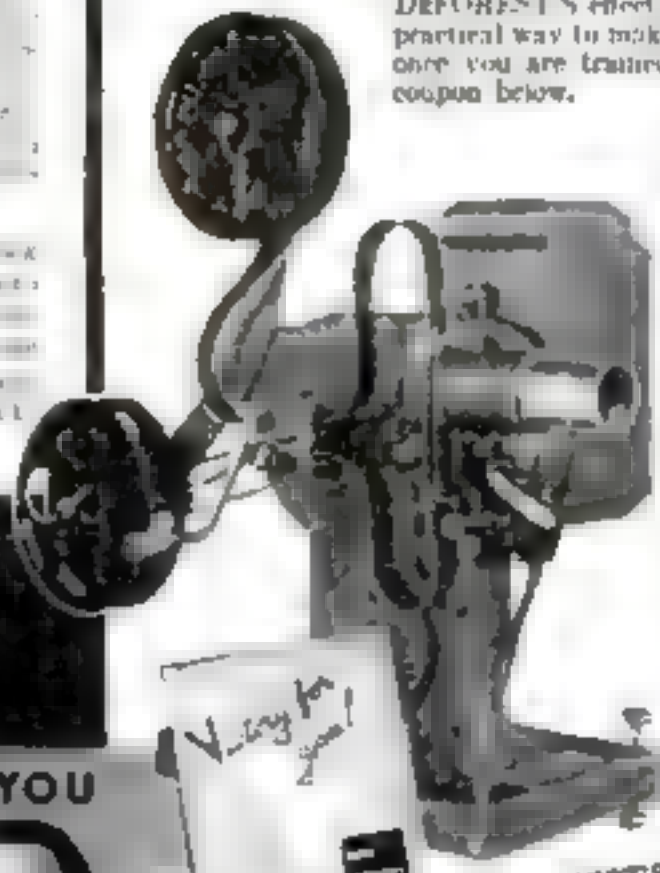

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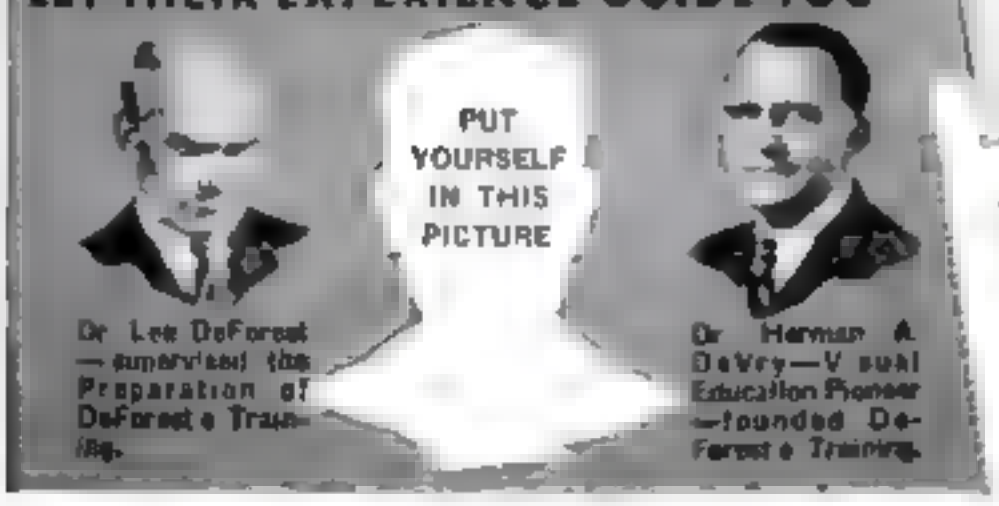

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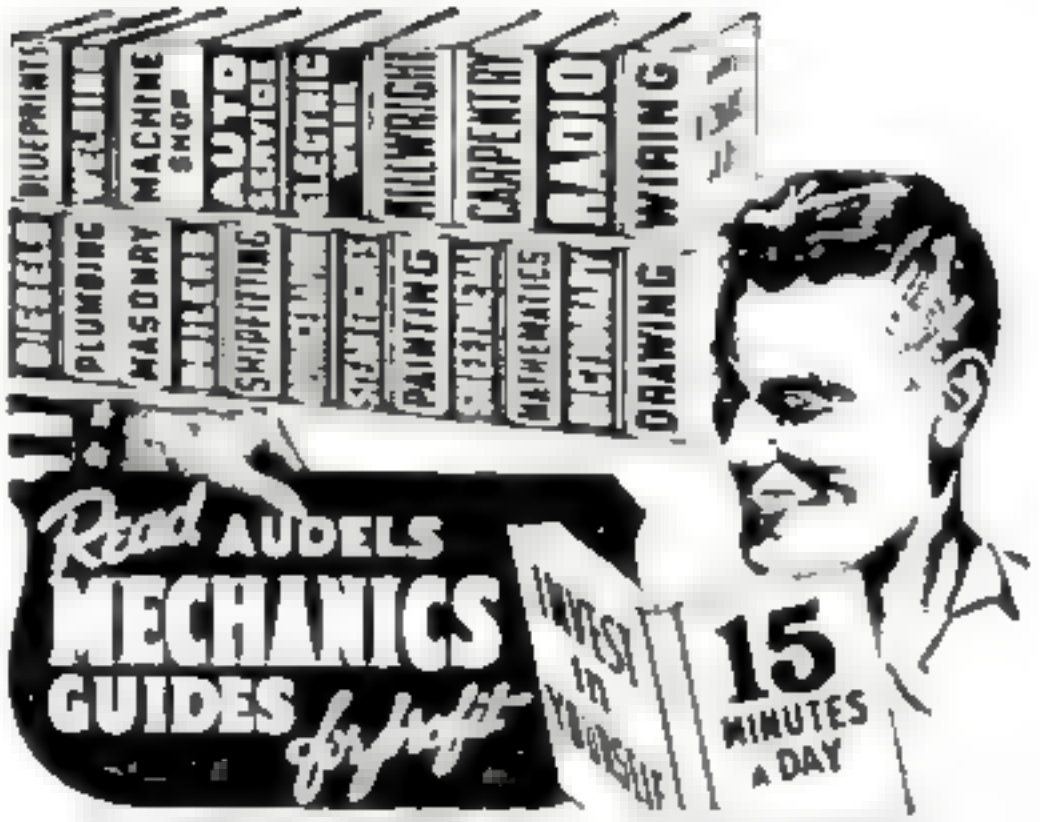

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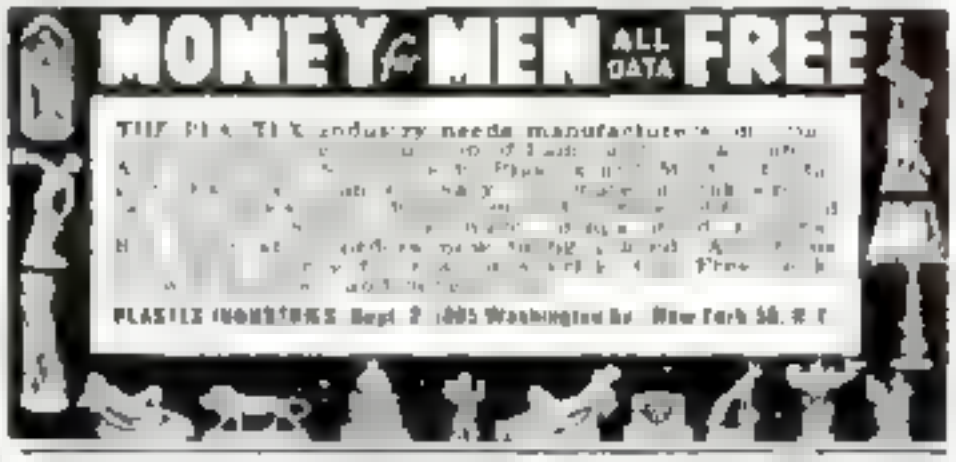

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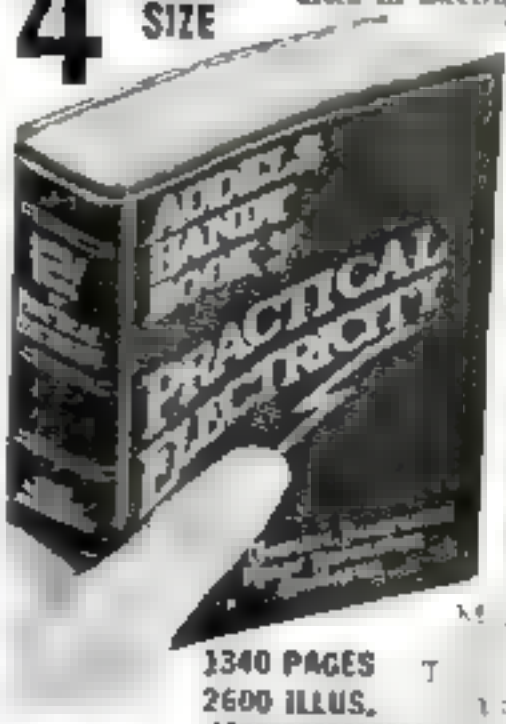

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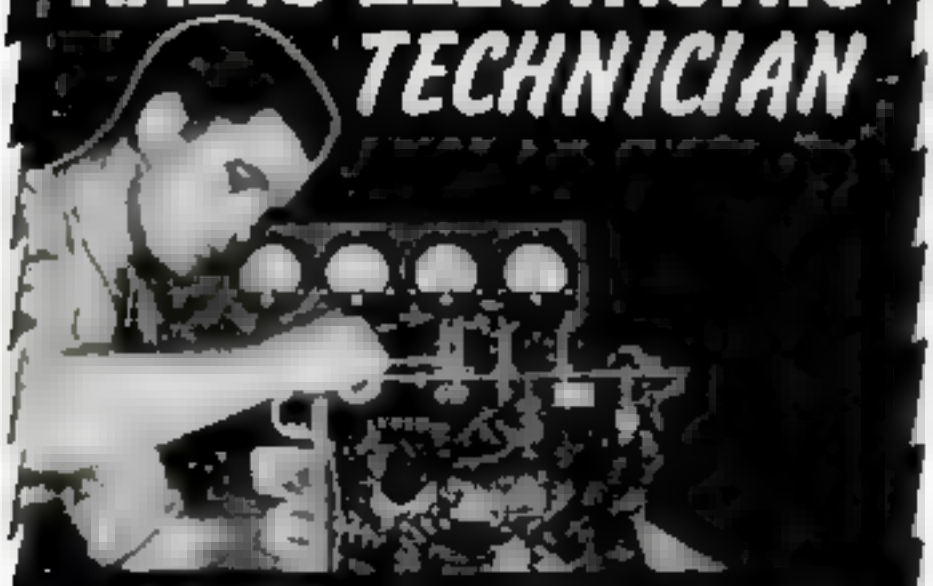

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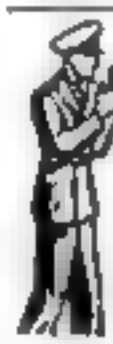

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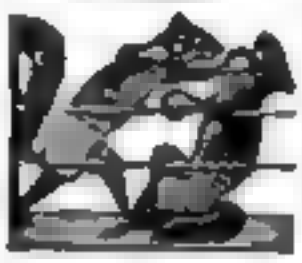

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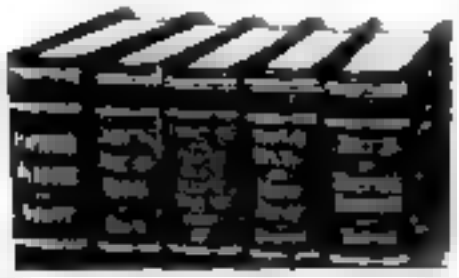

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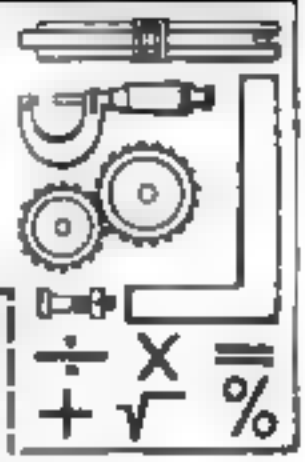

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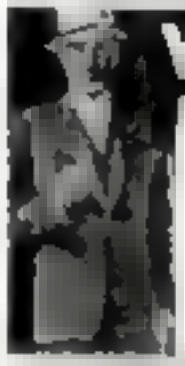

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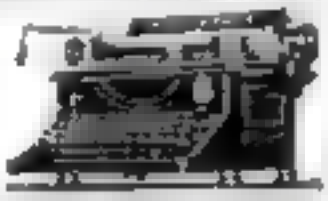

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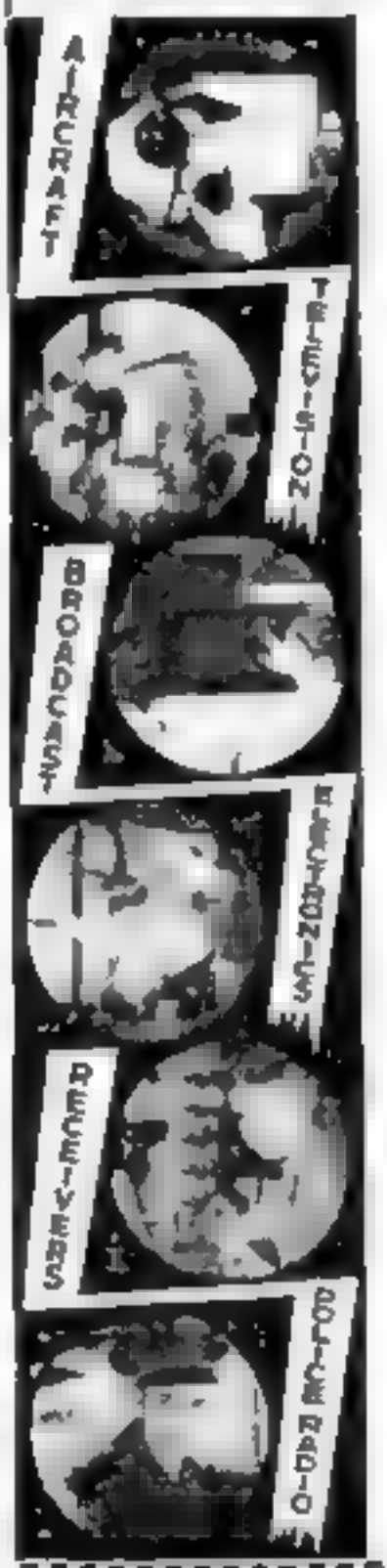

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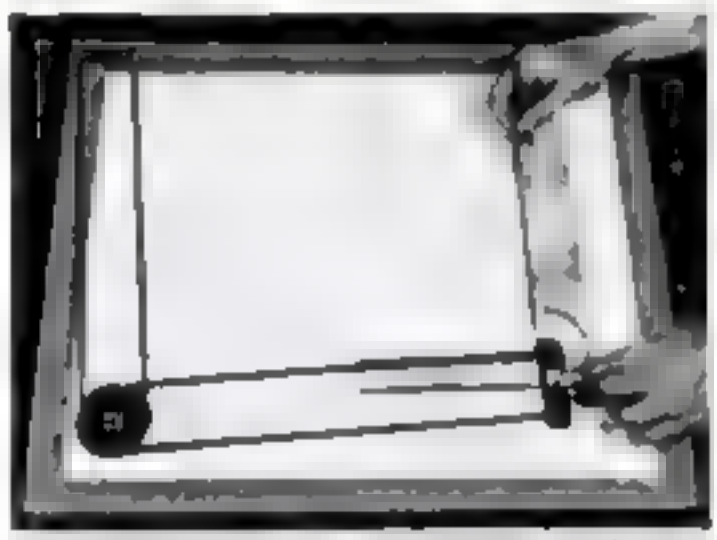

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To test a Navy rubber life raft and its accessories, six "castaways" are set adrift in the Atlantic under conditions simulating those of wartime shipwreck. Right, a "survivor" drinks from the new Permutit desalting bag being tested for Army and Navy flyers

A Drink from the Ocean

Flyers no longer need suffer the tortures of thirst when forced down at sea.... A compact kit employing a chemical precipitant offers a new solution to an age-old problem.

By

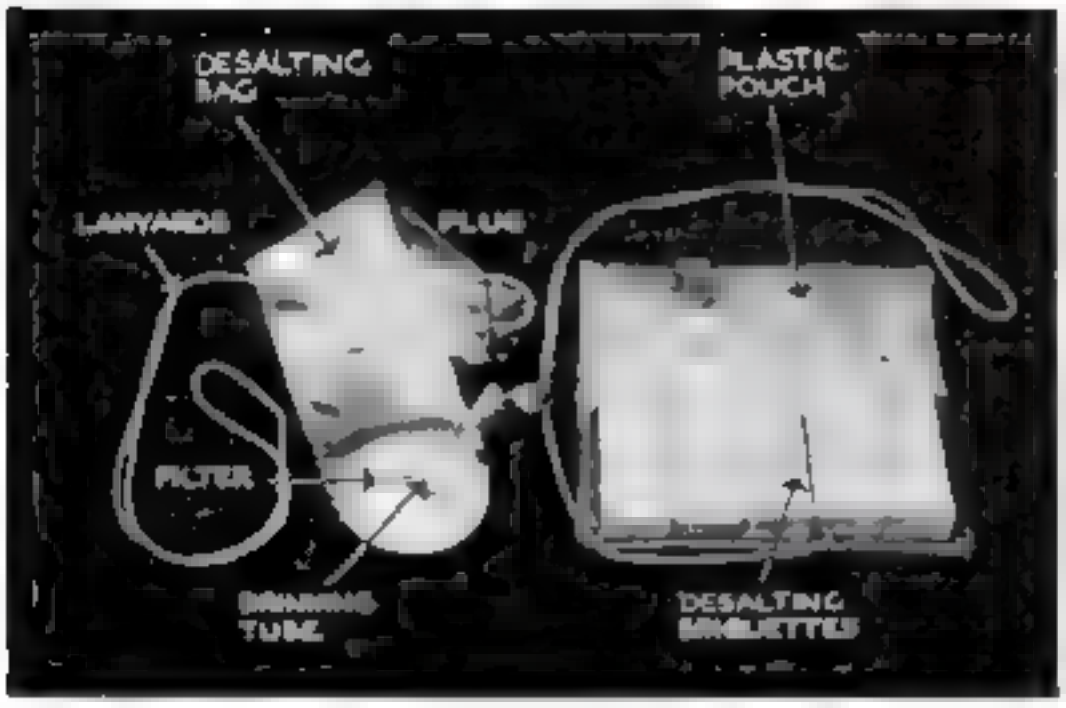
JEAN ACKERMANN

THE recent development of a chemical precipitant that makes sea water as safe and palatable as the water from your kitchen tap marks an all-time high in man's endless struggle with the problem of mid-ocean thirst. Never before was sea water purged of its toxic salts by a practical method employing chemical reaction.

Directly inspired by the needs of flyers for additional water rations without additional bulk, the desalting compound is being packed in a kit which will occupy the same space as the current G.I. water can in a 'chute pack.

The statistics are eloquent. An Army flyer now carries a 11.5-ounce can of water; a Navy flyer, two cans. Reckoning a pint per day as a base ration for a man, the

HOW NEW "DESALTER" PRODUCES A PINT OF



1 Simplest device yet developed for making sea water drinkable is the Permutit-Navy Desalting Kit. It consists of a plastic bag and five briquettes, each of which will desalt a pint of water—enough to keep a man going for at least a day

2 The pouch and desalting bag are both fitted with lanyards, which the user puts around his neck to keep them from getting lost overboard in rough weather

single can will last barely two days, while two may be stretched to last for three days. The kit, containing five briquettes, each capable of desalting a little over a pint, would give the Army flyer a potential of six pints; with one kit and one can, the Navy flyer would have a potential of seven pints of potable water.

Developed by the Permutit Company, a leading water-conditioning firm, with the advice of the Naval Medical Research Institute, at Bethesda, Md., the desalting process is as simple as making a cup of tea. Packed in the kit is a plastic drinking bag with a cloth filter at its base and a drinking tube set below this. There is also a supply of chemical, not identified at this time, which comes in compressed bricks, each the size of a candy bar. These are guarded from moisture by two heat-sealed wrappings.

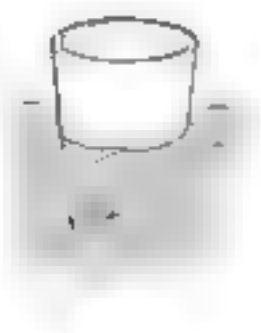
When he wants a drink, the castaway flyer scoops the bag full of sea water, drops in a briquette, straps the top opening closed, and shakes the bag from side to side to hasten the reaction. In 20 minutes the liquid is black with tiny granules. Of the 3.5-percent salt volume that sea water holds (2.7 percent sodium chloride; .8 percent salts of calcium, magnesium, and potassium), a total of 3 percent has been precipitated out.

To take a drink, the survivor simply uncorks the slim tube beneath the filter and sucks. The first mouthful will be salty, from filter leakage, but after that only a faintly stale taste distinguishes the desalted liquid from naturally fresh water.

Why wasn't such a simple solution thought of long ago? Probably because it was never so urgently needed before. The only hint of chemical desalting heretofore is a legend of some plant used by the Phoenicians to make salt water potable. Beyond this, mariners seem to have been content to use distillation methods, or to carry an ample supply of fresh water if the vessel was too small for a still. Distillation, the physical process of drawing off and condensing vapor from sea water, leaving the salts and other impurities behind, is still an excellent method for supplying large groups. But the weight and bulk of a still preclude its use on life rafts and small lifeboats, although there is an experimental miniature still that may become standard equipment in larger lifeboats.

As with Permutit, the great bulk of desalting research has been inspired by the war-born needs of airmen. One of the more

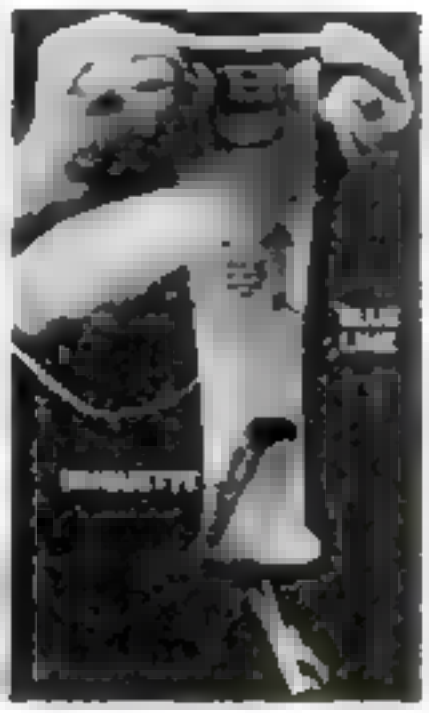
Alexander Graham Bell's Idea



The inventor of the telephone tried to solve the problem of drinking water for castaways. He worked, however, from the angle of condensing moisture from the atmosphere. His simplest plan was to float a tumbler on the ocean's surface. If sea-water temperature was below the dew point, moisture would condense in the tumbler. "But how fast?" Bell wondered. "Even a dew would be nectar to a thirsty man. But if it is no more, then a dew (adieu) to the man"

FRESH WATER FROM THE SEA IN 20 MINUTES

3 With bag filled to its blue line with sea water, briquette is dropped in through opening at top

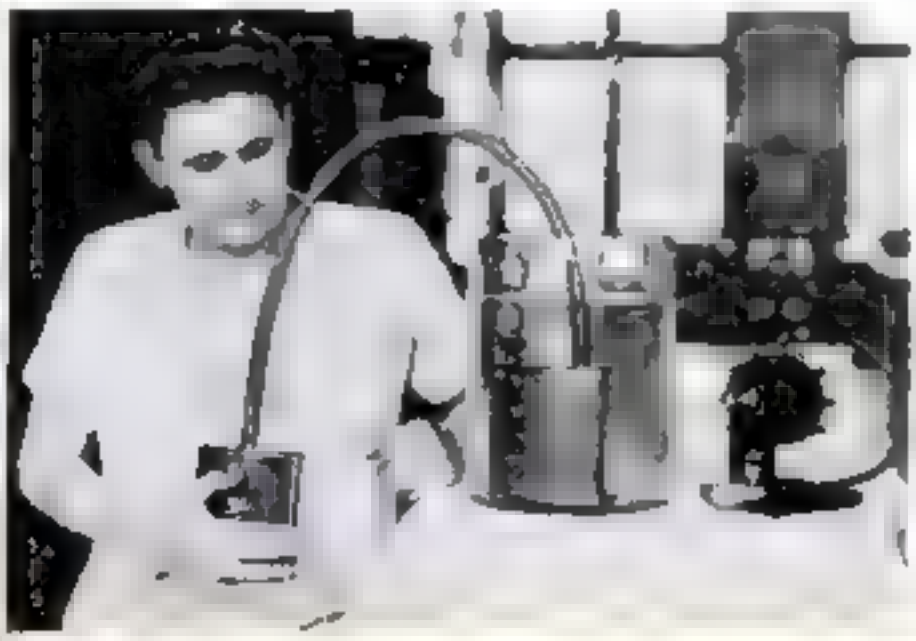


4 The top of the bag is then folded down four times toward plastic buckle and fastened

5 Bag is now kneaded and shaken to speed the distribution of the chemical. After 20 minutes of this, the user can remove the plug in the sucking tube and drink water that is still a bit salty but completely harmless

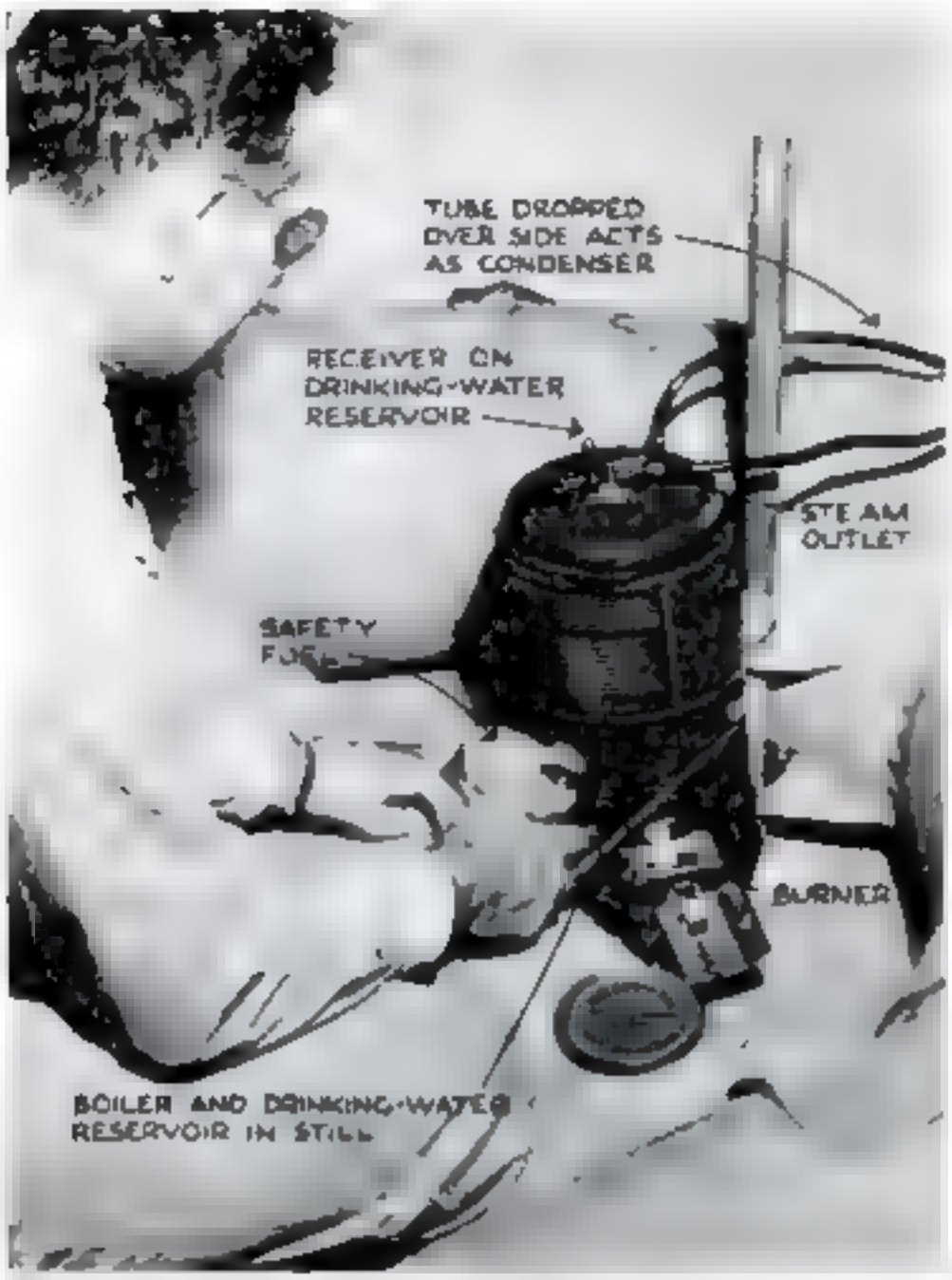
OTHER METHODS OF DESALTING SEA WATER

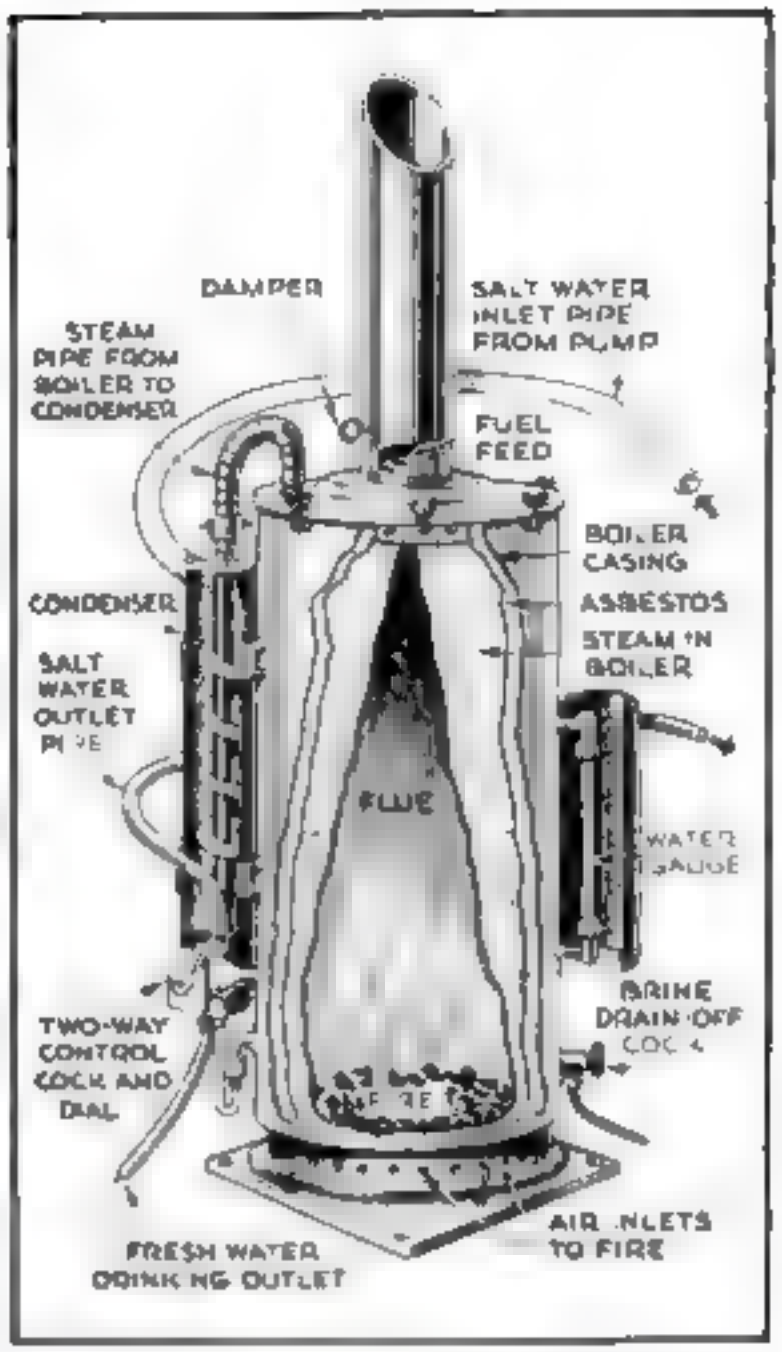
TWO-BAG DESALTER developed by the Navy is similar to Permutit device in that it uses secret desalting chemicals. Within 10 minutes it provides a man with drinking water for two days



SOLAR STILL. Sea water poured into chamber at top drips down to saturate black toweling, which absorbs heat from sun. The salt remains in the toweling while water vapor condenses and drips into container at bottom

BELLY STILL. Strapped to a man's stomach, this one-pint "boiler" uses body heat to turn sea water into a vapor that is carried to and condensed in a vessel trailing in the cool water of the ocean. Although simple to operate and requiring no fuel, it is cumbersome and takes eight hours to produce one pint of water





FUEL STILLS. At left, above, is a seven-pound still that produces about six quarts of drinking water for every pound of solid safety fuel that it burns. It is fitted with a flexible tube that is dropped over the side to serve as a water-cooled condensing coil. At right, above, is a still designed by the British for lifeboats. It can burn any type of fuel, and produces fresh water at the rate of five pints an hour

publicized methods was also a precipitation scheme, the work of physicist Alexander Goetz, of California. It involved four steps conversion of salts to alkalies, filtration, precipitation of the alkalies, and a second filtration. Intrigued by its possibilities, Navy researchers studied and improved upon the Goetz process to some extent, reducing the number of bags used from four to two. At its simplest, the Goetz method is still more complex than the Permutit-Navy process. It has never been officially adopted by any branch of the service

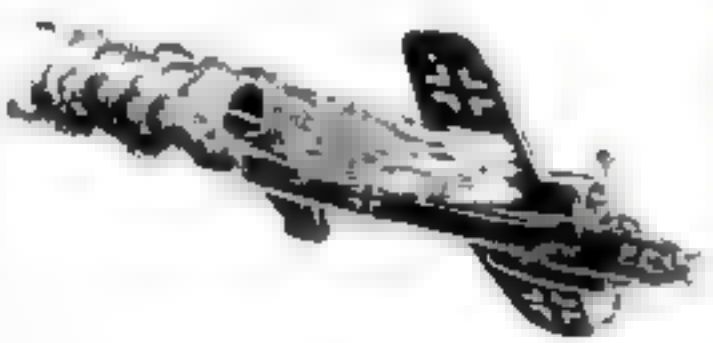
Though dissimilar in action, the Goetz and the Permutit-Navy devices share the advantage of compactness, so that they give a high ratio of water for their size and weight. The water cans used by our flyers weigh a pound each and hold only 11.5 ounces of liquid. The Permutit kit weighing less than a pound and a half, can produce five pints of water. But, like any other chemical method, its efficiency is always limited by the amount of chemical on hand. Other processes are just the reverse; the equipment is heavy and bulky, but it is self-sufficient. Given salt water, it can keep on producing fresh water indefinitely. One outfit, a compressor refrigerator, is based on the principle that when brine freezes, its salts center in "core water" in the middle of the ice, the ice itself remaining fresh and saltless. This is in the experimental stage.

Besides the miniature fuel-burning still mentioned above, two other small stills have been developed, both ingenious devices that save the weight of fuel by harnessing a natural source of heat. One, the "belly still" draws its heat from the human body. A hand-cranked vacuum pump keeps pressure in the "boiler" low enough that water evaporates at body heat. The resulting vapor is passed to a vessel trailing in the sea, which is never warmer than 78 degrees, the 20-degree drop is sufficient for immediate condensation.

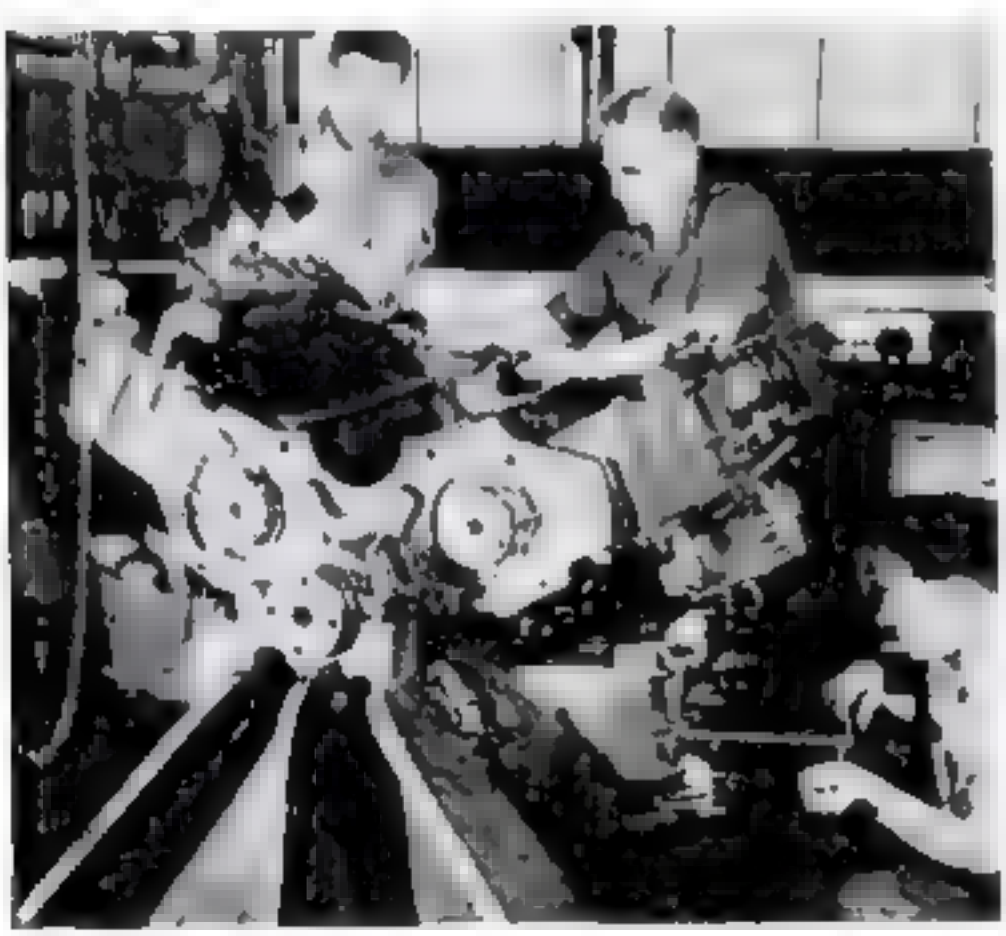
The solar still absorbs heat from the sun through a square of moist, black toweling. Evaporation from the wet cloth produces water vapor, which condenses on the inner side of a Vinylite covering and drips down to a tube from which it can be sucked

FOUR-WAY PROTECTION for fighters is provided by the Navy's latest battle costume. Though it weighs less than four pounds, the garment contains enough kapok stuffing to stop bomb and shell fragments, keep the wearer from drowning, and prevent "blast" shock from underwater explosions. It also guards against burns.

Here are two styles of the Navy's battle costume. Officer holds a one-man rubber boat which can be worn collapsed on the back. A pull on a cord inflates it—with the man inside



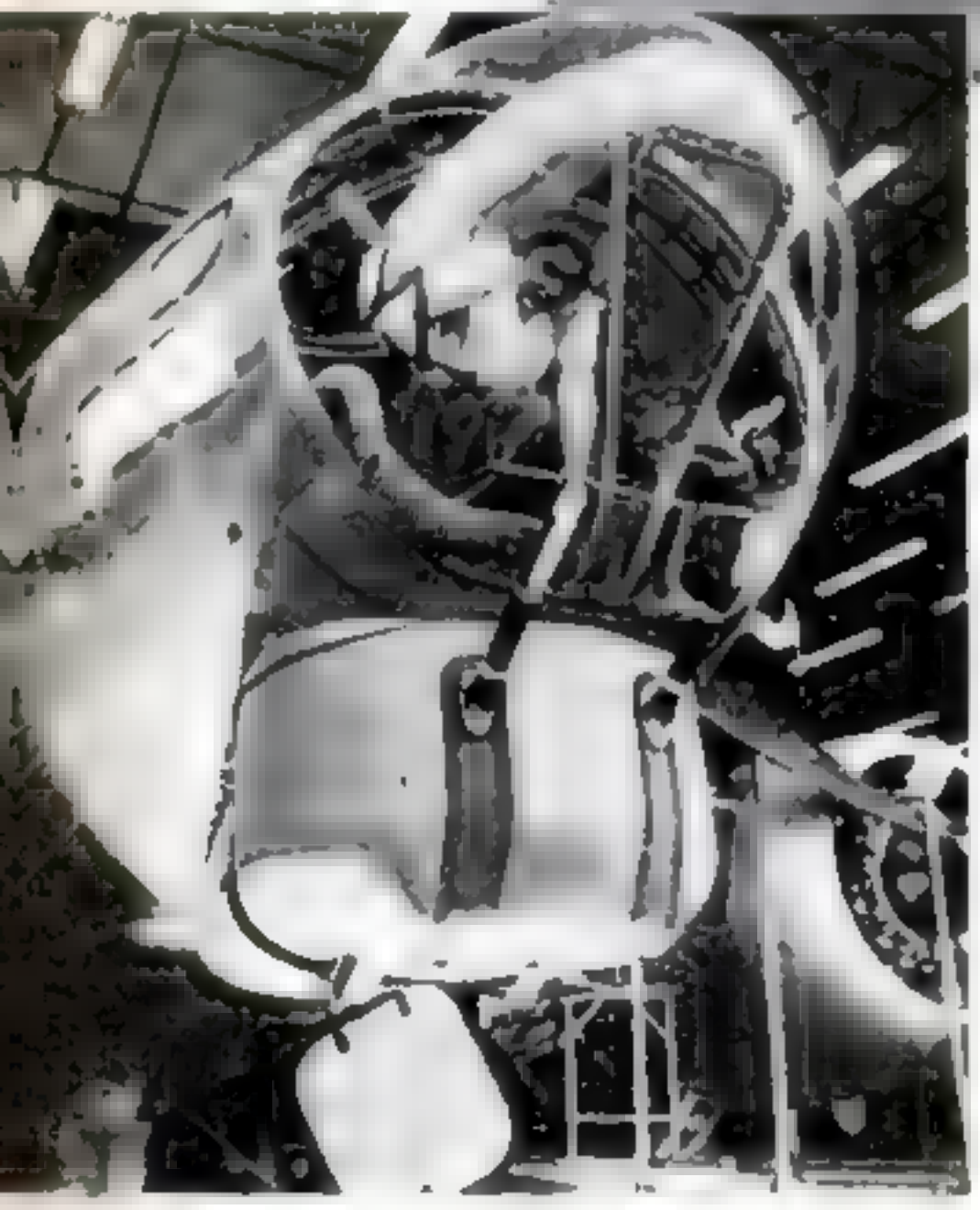
BLAST-FURNACE temperatures of new U. S. incendiary bullets turn enemy aircraft into sheets of flame. Self-sealing gas tanks, immune to tracer bullets, ignite as the new ones pass through. Rounds alternate with armor-piercing and tracer ammunition.



FIVE AUTOMOBILE ENGINES equal one tank engine. How Chrysler Corporation engineers, following this remarkable formula, helped to develop a power plant used on thousands of medium American tanks has just been revealed. In the photo above, four six-in-line auto engines have been assembled around a single crankshaft. A fifth completes the job.

BOMB REFUGE? Oddly patterned after less permanent air-raid shelters, the massive structure below was found intact at Naples, Italy, after the Allied occupation. Ruins of surrounding buildings suggest that its design spared it a similar fate, although whether it was actually used as a bomb refuge remains a mystery.

operates a power-driven "chin turret," shown below and at right, on the eighth and latest model of our Flying Fortress. Replacing flexible-type guns, the two .50 caliber turret guns repel frontal attack on the B-17G believed the world's hardest bomber to down



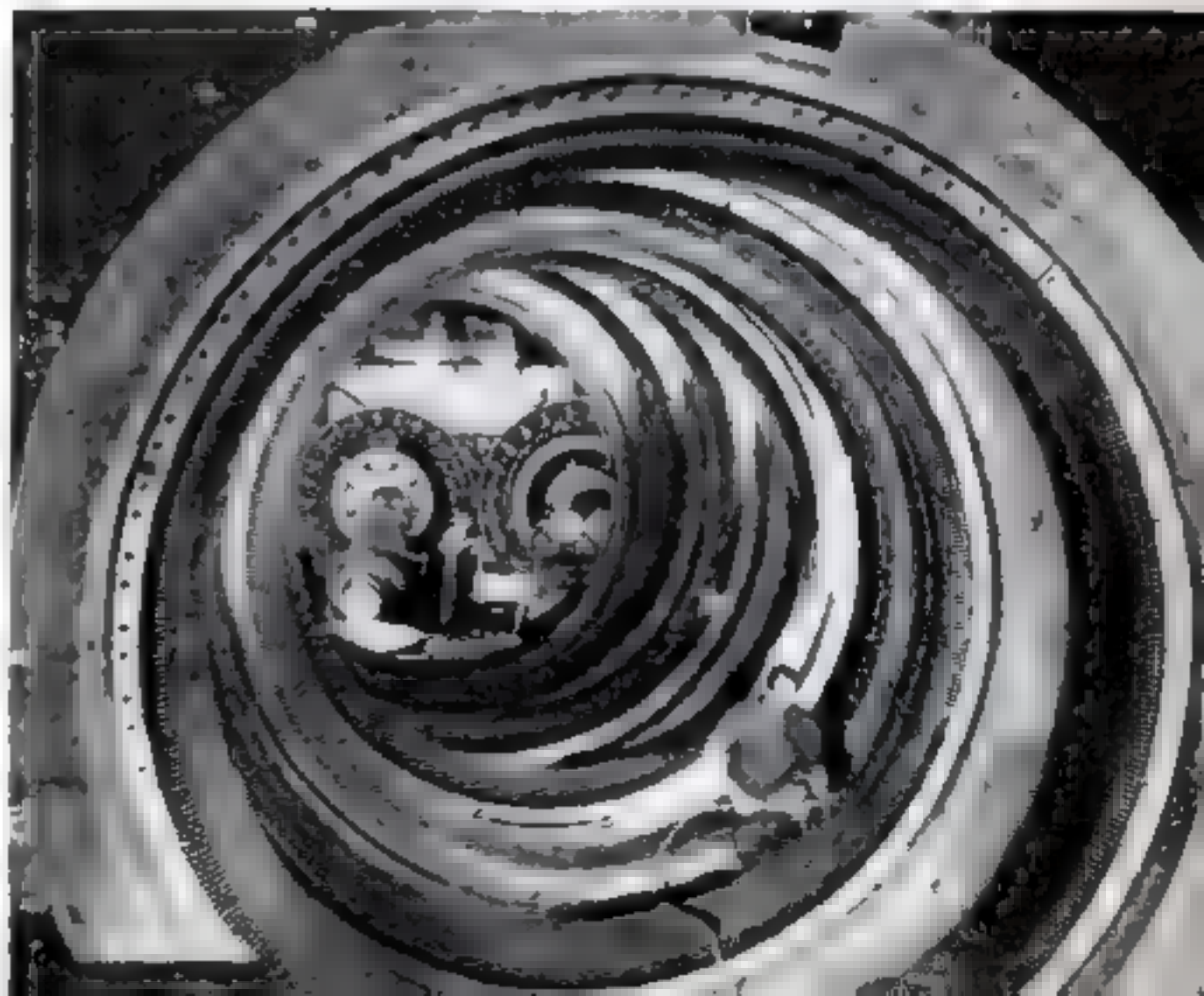
IT'S KNIVES against the jungle—sometimes more dangerous than any human foe—if Australian pilots of seagoing Spitfires have to make forced landings far from civilization. Secured to the boots of the fivers, as illustrated below, the wicked-looking blades serve as machetes to hack a way through matted undergrowth—or enemy patrols until a friendly outpost is reached

TWENTY-FIVE CASTAWAYS, with enough supplies to last them 30 days, find ample room in the world's largest rubber raft produced by the Firestone Tire and Rubber Company and tried out by the Coast Guard. Deflated and packed, as at lower left, the boat measures only seven by five by 1½ feet. Only four minutes are needed to unpack and launch it. Three transverse pneumatic benches, 10 feet long, serve as seats; a weather curtain (lower right) protects occupants from wind, water and sun

THE LARGEST nonrigid airship ever built is being test-flown by the Goodyear Aircraft Corp., Akron, Ohio. Designated the M-1, this super blimp will serve the Navy, cruising up and down the coasts in search of enemy submarines. Compared with the naval K-ships which have been on coastal patrol, the M-1 is larger by 50 percent and holds 50 percent more helium. Greater size and volume of the giant ship permit larger cruising radius and bomb-carrying capacity. In the photo at the right can be seen the airdock of the plant in Akron where the partially filled gasbag awaits placement of a nose cone

AIR FREIGHT is quickly stowed or discharged by the new Hi-Lift Sky Freight Loader, seen at left, designed for the Army Air Corps by the Heil Co., Milwaukee, Wisc. Twin cylinders on the unit lift cargo, weighing up to 8,000 pounds, to any plane-door level between 4½ and 10 feet high—the distance from the door sill to the ground varying with every type of plane

MOTOR FRAMES that will house rotors of 6,000 to 10,000 horsepower are lined up at left for inspection at the General Electric plant, Schenectady, N. Y., before being installed in U. S. tankers and factories. When assembled with motors, the four frames in front will be part of a unit weighing 112,000 pounds; behind these are three which in complete assembly will weigh 145,000 pounds. Two great rotors in the background were designed for a 10,000-horsepower, 850,000-pound twin engine in a steel plant that will be the largest west of the Mississippi.



What's New in Helicopters

SIMPLIFIED CONTROLS are an outstanding feature of a new helicopter design developed by the P-V Engineering Forum, of Philadelphia, Pa. A midget model, using a three-blade rotor of 25-foot diameter, is shown being demonstrated at the National Airport in Washington, D. C., by Frank N. Piasecki

HIGGINS, builder of landing boats for Uncle Sam, will bid for the postwar helicopter market with the craft shown in the drawing at the left. It was designed by Eneas Bossi, who built Italy's first airplane in 1909, and will be built in Louisiana.

TWIN ROTORS lift and propel a teardrop plywood craft designed and built in his spare time by Fred Landgraf, engineer at a Los Angeles, Calif., aircraft factory. By eliminating the problem of torque, the twin-rotor feature makes it possible to replace the usual rear rotor with a vertical fin. The twin rotors have 16-foot diameters. Landgraf will test-fly the plane within a few weeks.

How Strong Is Germany's "Fortress Europe"?

The road to Berlin is guarded by the greatest defensive system in history . . . but our forces will hack through to victory.

By HAL BORLAND

Drawings by DOUGLAS ROLFE

EVERY day's fighting in Europe carries our armies closer to Hitler's Inner Fortress, where the decisive battles will be fought and the war will be won. Many secrets of that Inner Fortress are now known and have been studied exhaustively by the Army Engineers, whose job it is to open the way for the conquering armies. How these secrets were learned cannot be told until after the war, but the outline and much detail of the Fortress itself may now be revealed.

First of all, it must be understood that the name "Fortress" is deceptively simple. All occupied Europe is a part of the mammoth system of defense the Nazis have devised. The Inner Fortress itself is more than twice the size *(Continued on page 58)*

THIS IS THE "INNER FORTRESS"

German ingenuity has turned all of occupied Europe into a fortress, but the real citadel of Nazidom is the steel-ringed area outlined roughly in the map on the two following pages

ENG. CHANNEL

FRANCE

BELGIUM

NETH.

GERMANY

SEINE

PARIS

BERLIN

ELBE

ODER

NURNBERG

DANUBE

SWITZ.

MUNICH

ALPS

AUSTRIA

CZECHOSLOVAKIA

RHONE

TOULON

YUGOSLAVIA

HUNG

DANUBE

ADRIATIC SEA

DINARIC ALPS

APENNINES

MEDITERRANEAN SEA

LEGEND

COASTAL AND LONG-RANGE ARTILLERY	
RAILROAD ARTILLERY	
PELLED) ARTILLERY	
FIXED AND MOBILE FLAK ARTILLERY	
TANK DITCHES	
TANK WALLS & WIRE ENTANGLEMENTS	XXX XXX
MINE FIELDS	
BUNKERS AND FORTIFIED STRONG POINTS	
AIR BASES FOR DIVE BOMBERS & FIGHTERS	

BALTIC SEA

LATVIA

LITHUANIA

BELORUSSIA

EAST PRUSSIA

POLAND

VISTULA

WARSAW

PRIPET

PRIPET MARSHES

U.S.S.R.

KIEV

DNIEPER

CARPATHIANS

RUMANIA

SOUTH

TRANSYLVANIAN ALPS

BALKAN MTS

BULGARIA

RHODOPE MTS

TURKEY IN EUROPE

DONETS

R.

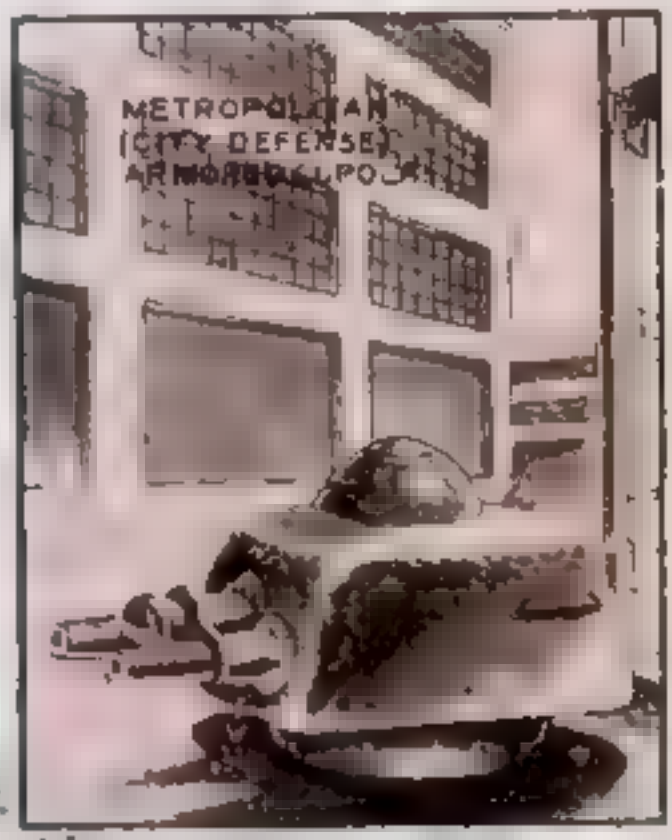
STALINO

SEA OF AZOV

MAIKOP OIL FIELDS

SEVASTOPOL

BLACK SEA



of Texas. Its boundaries are, roughly, the Baltic on the north, the Vistula and the Dniester on the east, the Danube and the Po on the south, the Rhine and the Siegfried Line on the west. It includes not only Germany, Austria, Hungary, Czechoslovakia, Poland, and Rumania, but slices of the Baltic States, Russia, Yugoslavia, Italy, France, and Belgium.

These defenses are no single line of fortification. Their extent varies greatly with their situation, but in general they are an elaborate system of defense in depth—with the accent on depth. Thus, the occupied area outside the boundaries cited is actually a part of the defensive system. It is a huge maneuver area, a cushion to absorb the shock and soften the sledge-hammer blows of the Allied armies driving in toward the Inner Fortress.

And, finally, the Fortress is more than a system of fixed fortifications. It is mobile defense as well, the area inside being criss-crossed with lines of communication, highways, railroads, navigable rivers, and canals, and dotted with major air bases. Look at the map and you will see how well the outer lines take advantage of natural barriers, chiefly rivers and mountains. You may be sure that every range of hills and every watercourse in the maneuver area is a part of the intricate defense.

With this broad picture in mind, lay out a line of approach to Berlin from any point on the periphery—from the Channel, from the North Sea, from the Mediterranean, from Russia, from the Balkans—and you can begin to understand the possible problems for an invading army. The Nazis have not overlooked any of the possibilities.

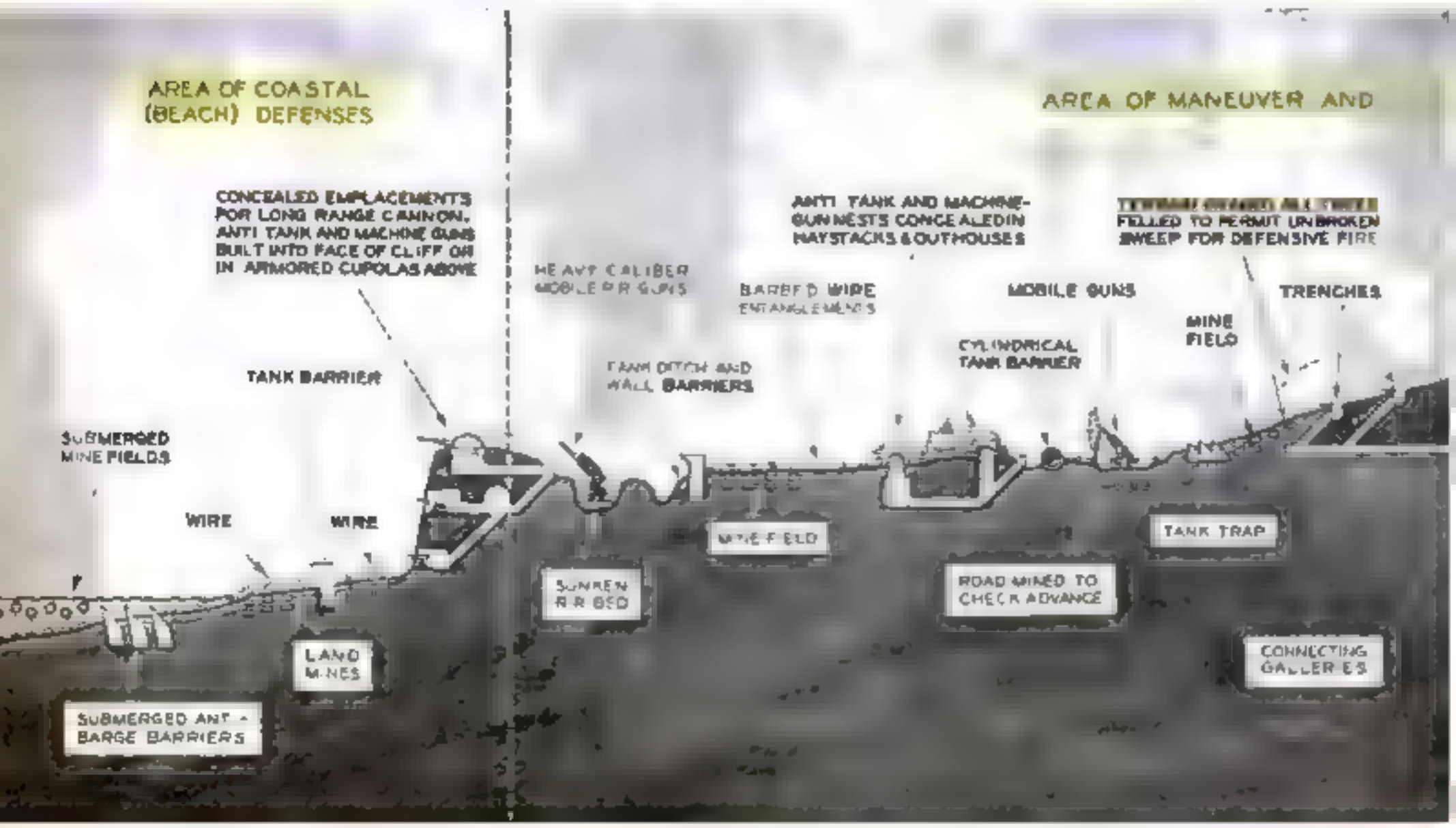
Suppose the approach is from the sea. The first problem is that of landing. Coastal defenses are particularly heavy, especially at favorable invasion points. The water is alive with mines. The land rises sharply above a relatively narrow beach, and on the heights are gun emplacements—every type of weapon from machine guns to 16-inchers with a 30-mile range. Just back of these emplacements are rail lines, and all along the coast are big guns on railroad mounts, which can be moved into position overnight.

In the water just offshore are steel and concrete barriers, shark-tooth affairs designed to rip the bottoms out of landing barges. The beach itself is sown with land mines—the deadly Tellers to blast tanks and the terrible S mines which leap from the sand at the slightest touch and spray shrapnel at belly height. Literally millions of mines have been planted along hundreds of miles of beaches. Back of the mine fields are tank barriers, which include everything from concrete walls and steel rails bedded in concrete to roll barriers which look like gigantic sewer pipes six feet in diameter. Around these barriers and behind them is the wire—thick, tough, heavily barbed, and set up in an endless tangle.

This is where the invaders must set foot on land.

Back of the beach are villages and the open country. The few roads leading to them bar every kind of vehicle with walled mazes, steel rails, and concrete blocks.

DEFENSE IN DEPTH. Surrounding the bastions of the Inner Fortress itself is a vast maneuver area, designed to cushion the blows and sap the strength of an invading force before it reaches the main defenses



Guarding these roads are guns hidden in the walls of old stone buildings, guns set into the hillsides, guns commanding street and road intersections. And overhead, of course, is the *Luftwaffe*—as much of it as can get through our own air umbrella—operating from a dozen fields back beyond the hills.

This is the first line beyond the beach, actually a part of the beachhead defenses. Once it is breached, the attackers can move on into open country.

But the open country is not so peaceful as it looks. Roads are barricaded, and the barricades are guarded by gun emplacements which have been there so long that the wind and weather have blended their concrete and stone with the hillsides, and the grass and bushes have provided perfect camouflage. As the tanks and trucks leave the roads and cut across country they find themselves again in the midst of mine fields over which the grass has grown a perfect cover. Every watercourse is a hazard. Not only do its banks hide gun emplacements, but it must be bridged under enemy fire. Mobile artillery has moved in behind the next range of hills.

This is the open country, the maneuver area. Here and there are "strong points," pillboxes, and special cover for rifle companies; and always there is mobile defense moving up, hammering and delaying the invading force. Tank companies make driving flank attacks. Tank killers wait on the hilltops and beyond the streams. Every wooded area is a nest of artillery, hastily drawn up from less-menaced areas.

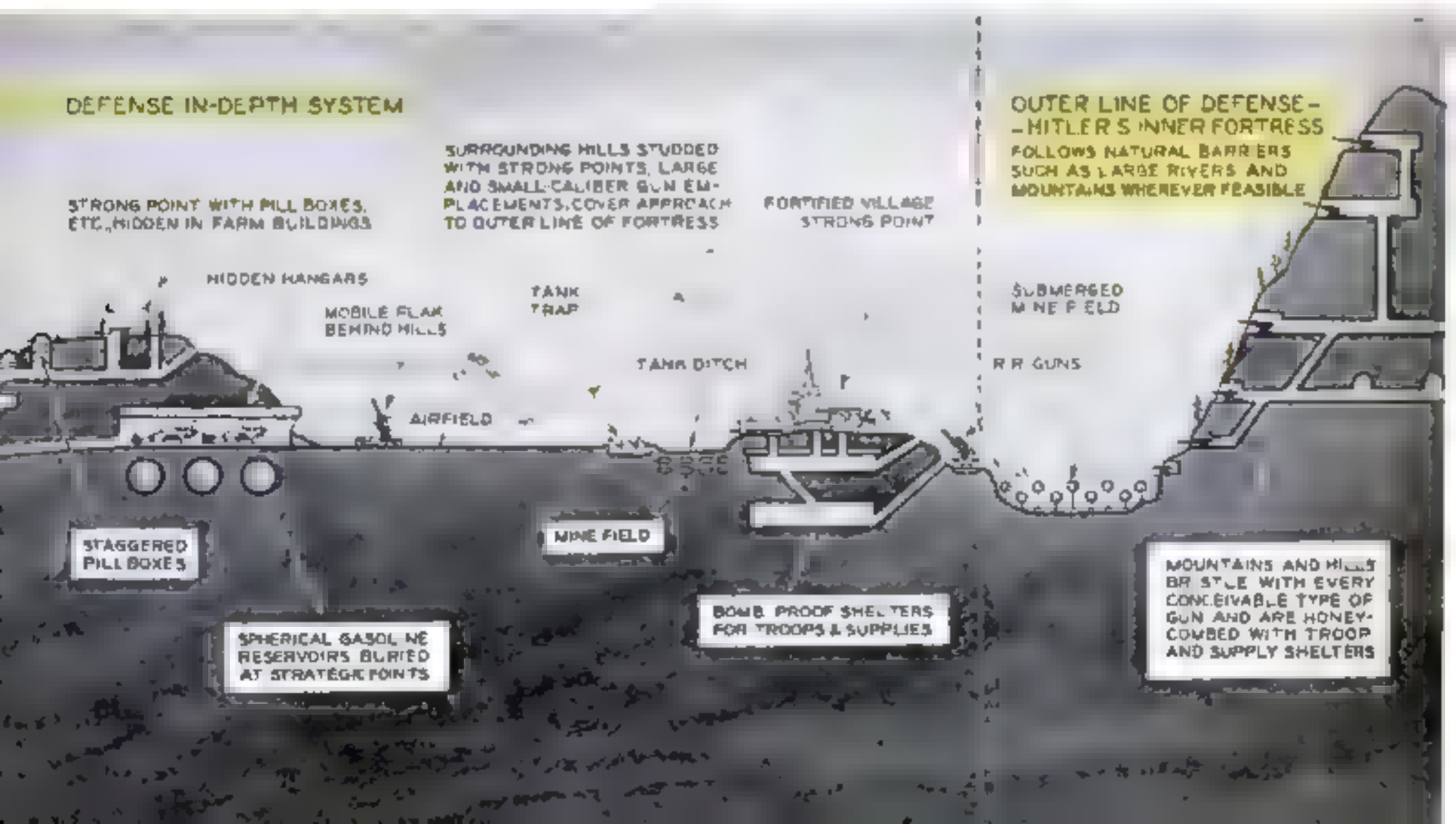
As the invading armies move on, the defense deepens. By now, reinforcements of every kind have been gathered, and the tank battles roar to the heavens, more often than not masked in a rolling screen of smoke. Villages become minor fortresses, with guns hidden in barns, houses, pigsties, and haystacks. Antiaircraft guns are lowered to pour concentrated hell into the advancing armies.

At last the invasion reaches the outer lines of the Fortress itself.

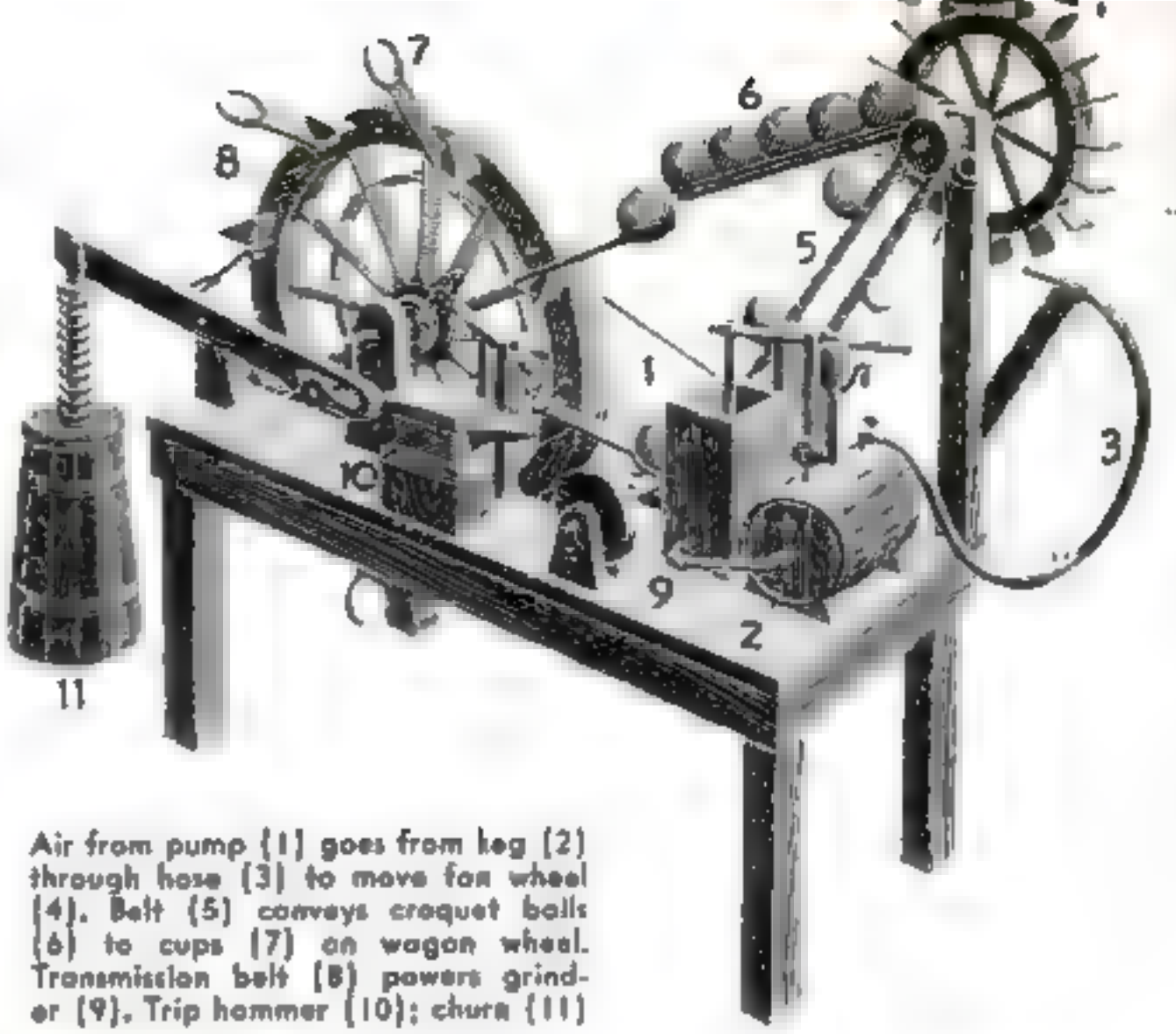
At the risk of oversimplification, let us say there are three roughly parallel lines of fortification, the second line from six to 10 miles behind the first, the third as much as 25 miles back of the second. The first line will have, in a typical area, a frontal defense of tank traps. These consist of everything from broad, deep ditches to concrete barriers. Their purpose is to halt the tanks long enough for the antitank guns to get in their heaviest blows. Tanks can cross ditches, but, as they emerge, their lightly armored underbellies are open to brutal fire. They can sometimes crawl over the concrete barriers, but there again their bellies are exposed.

Behind the tank barriers are endless snarls of wire which tangle in tank treads and slow up engineers and infantry. Under and behind the wire are land mines in countless numbers. Beyond the mines are bunkers and blockhouses, set into the hillsides like molars into a jaw and pouring steel and death into the oncoming armies. No two bunkers are built the same, and each one's guns cover at least two of its neighbors. Nor are *(Continued on page 204)*

This cross section, greatly compressed, shows how gun emplacements, strong points, and open ground are mingled to give the greatest possible opportunity for mobile defense by artillery and fast mechanized forces

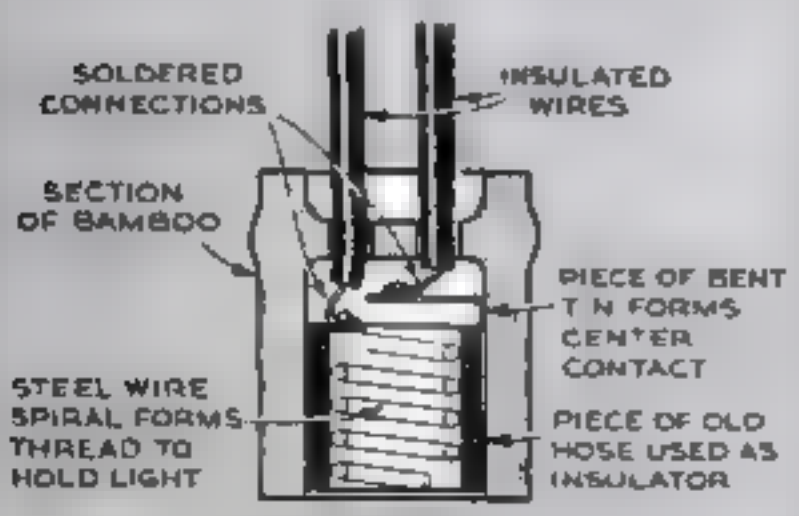


A PERPETUAL-MOTION machine built by Capt. Eddie Rickenbacker at the age of 14 has taxed the ingenuity of Twentieth-Century Fox Studios. In their new film "Rickenbacker—an American," the apparatus is shown as it originally appeared, centering around a hand-operated air pump and incorporating a keg, wagon wheel, bicycle rim, and several croquet balls. Rickenbacker found at its first trial that the machine fell apart, but Hollywood prop men made it work by putting a motor under the table top on which it rested and concealing wires in the table legs. A D.C. motor drives the wagon wheel; and to heighten illusion, a second one gives the apparatus a bouncing motion. Smoke and sparks accompany the scene of its breakdown.

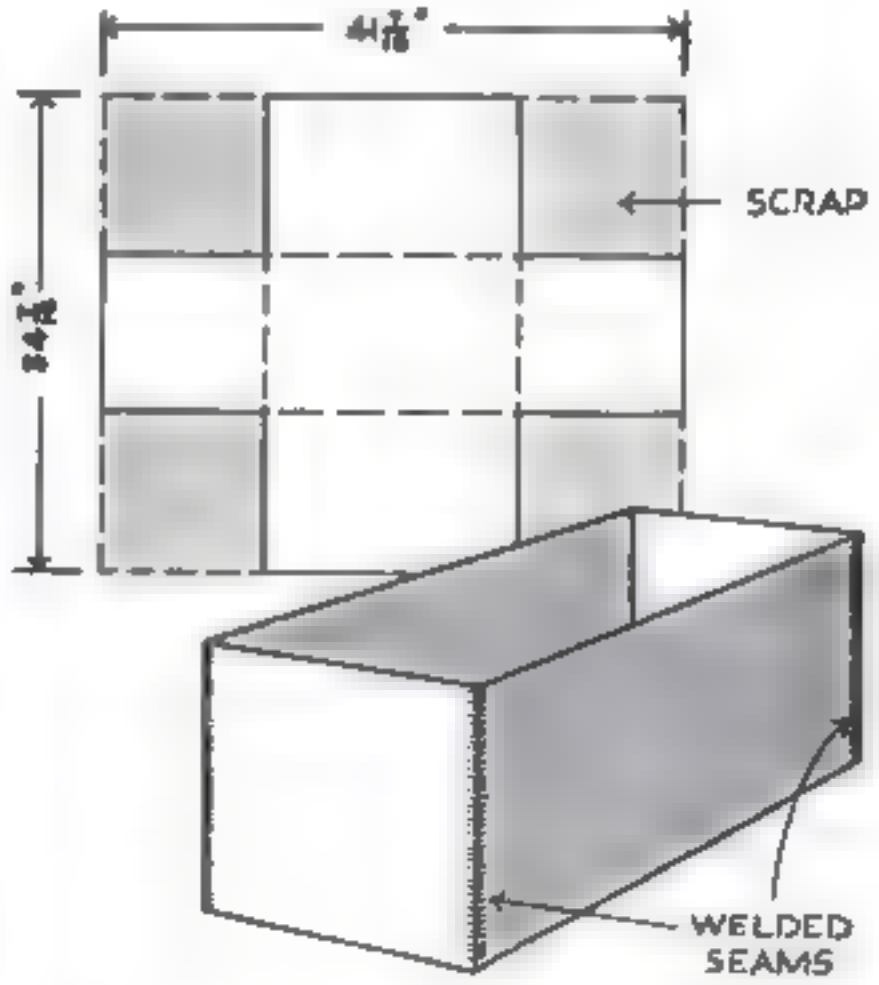


Air from pump (1) goes from keg (2) through hose (3) to move fan wheel (4). Belt (5) conveys croquet balls (6) to cups (7) on wagon wheel. Transmission belt (8) powers grinder (9). Trip hammer (10); churn (11)

A SHORTAGE of lamp sockets somewhere in the South Pacific has been eased by two Navy "Seabees, G. A Brien and E. S. Ryan. Working with worn-out hose, steel and insulated wire, bits of tin, and sections of bamboo, they fashioned the socket shown.



SPARE-PARTS BOXES of aluminum made by Westinghouse now require less metal than formerly, yet they remain the same size. An ingenious pattern for cutting the boxes reduced the sheet of aluminum needed for a single box from approximately 10½ square feet to 7½ square feet. The new box, designed by Emil Stolte of Westinghouse, is stronger, requires less welding, and annually saves two tons of aluminum. See if you can revamp the old pattern, below, to save three square feet of scrap. *(Solution on page 106.)*



Mastery of a bulldozer is one of the things this Seabee recruit learns. Overseas, and under fire, he may take it apart, put it back together, and make it do tricks

The Seabees Can Do It

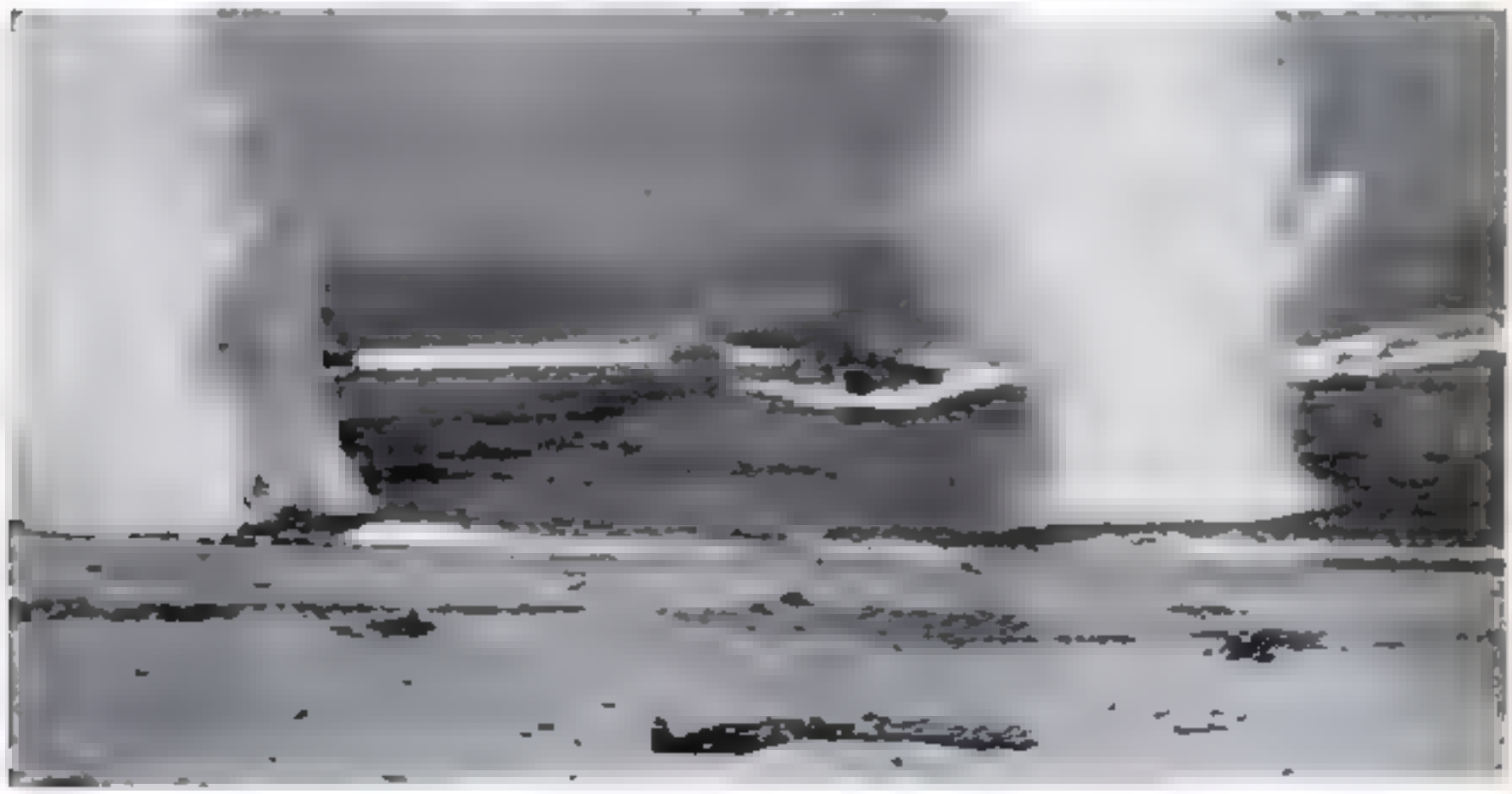
Whatever the job, the Navy s Construction Battalions will tackle it . . . with their own brand of rough-and-ready engineering.

By ALBIN E. JOHNSON

OFFICIALLY they're known as the U. S. Navy Construction Battalions. Popularly they're called the Seabees, a play on alphabetics. Among themselves, and by the regular Navy and the Marines who have seen them in action on the beachheads and bases of the seven seas and in Alaska and Greenland, they are the Can Do's—the boys who can do, and *do* do anything. They are to the Navy what combat engineers are to the Army. Their motto is *Construimus Batuimus* (We Build and We Fight), and they are one of the secret weapons of this war

Ben Moreell (Rear Admiral Moreell, to be formal), chief of the Navy's Bureau of Yards and Docks, goes all out for his Seabees. Taken from the ranks of civilian con-

Intensive training in landing operations condit ons Seabees for going ashore as engineers with our first waves of invading troops. These bomb bursts simulate actual conditions in exercises on the East Coast



struction workers and technicians, they now have reached the formidable total of about 200,000 and are still being recruited. Moreell recalls what they did at one spot in the South Seas, where they were sent after Pearl Harbor.

"A supply road was needed there," he recounts. "Ten Seabees with two Diesel bulldozers were available for the job. The problem was to construct a 10-mile road over a 1,500-foot mountain ridge, through virgin jungle so tangled that a man could not penetrate it. The Seabees split into two gangs, worked 12-hour shifts, and for three days and three nights they kept the two bulldozers going constantly except for five-minute stops between shifts to refuel. Having no spare parts, they improvised repairs. In 72 hours the first jeep went over the road to the new base."

Improvisation is the watchword of the Seabee, and ingenuity is inherent in his character. There isn't a piece of machinery he can't fix. Moreell tells of the radio condenser that went haywire at a remote base. The nearest new parts were 1,000 miles away. Seabee Phillips, chief petty officer and former carpenter, collected tin foil from cigarette packs around the camp, some waxed paper from a fruitcake which a sailor had received from home, and a flatiron. He rolled out alternating layers of tin foil and waxed paper, stuffed them into a discarded beer tin, and made a condenser that worked.

"If a Seabee doesn't know the answer," says Moreell, "he makes up one."

The war had not been under way long when a crew of 40 Seabees were transported to Liberia by Clipper to do a rush job. In six weeks they built 13 lighters, and improvised barges which they made out of pontons equipped with cranes. They were on the job seven days a week, from the crack of dawn until dusk, in steaming tropics where the thermometer climbed to 140 degrees in the sun. And they finished the job on time.

The British had been trying for three months to assemble a crane; the Seabees took over and had the operation ready in a month. They dug one crane out of the weeds where it had lain for nine months. British sailors had discarded an old boat because it wouldn't run; with a screwdriver and pair of pliers, Seabees took the engine apart, cleaned it, installed a handmade condenser, got two cylinders working, and made the boat serve until their equipment arrived. Defective spark plugs, low-grade gasoline, and various other kinds of grief didn't prevent the Seabees from having the landing barges ready when freighters and cargoes began to arrive.

Seabee construction odysseys are also being written on the barren tundras of Alaska and in the rocky Aleutians. There Seabees shared foxholes and dugouts with the soldiers and sailors at Attu; they built barracks at Dutch Harbor when Japanese bombs were falling and the williwaws—the terrific windstorms of that region—ripped apart the Quonset huts as fast as they were bolted together. A williwaw carried one Seabee 30 feet through the air. Another Seabee broke that record with a 40-foot flight, and got a fractured leg. Divers worked in water 108 feet deep and so cold that the oxygen hoses froze. One Seabee diver carried black and blue marks for three weeks as a result of too close acquaintance with an octopus.

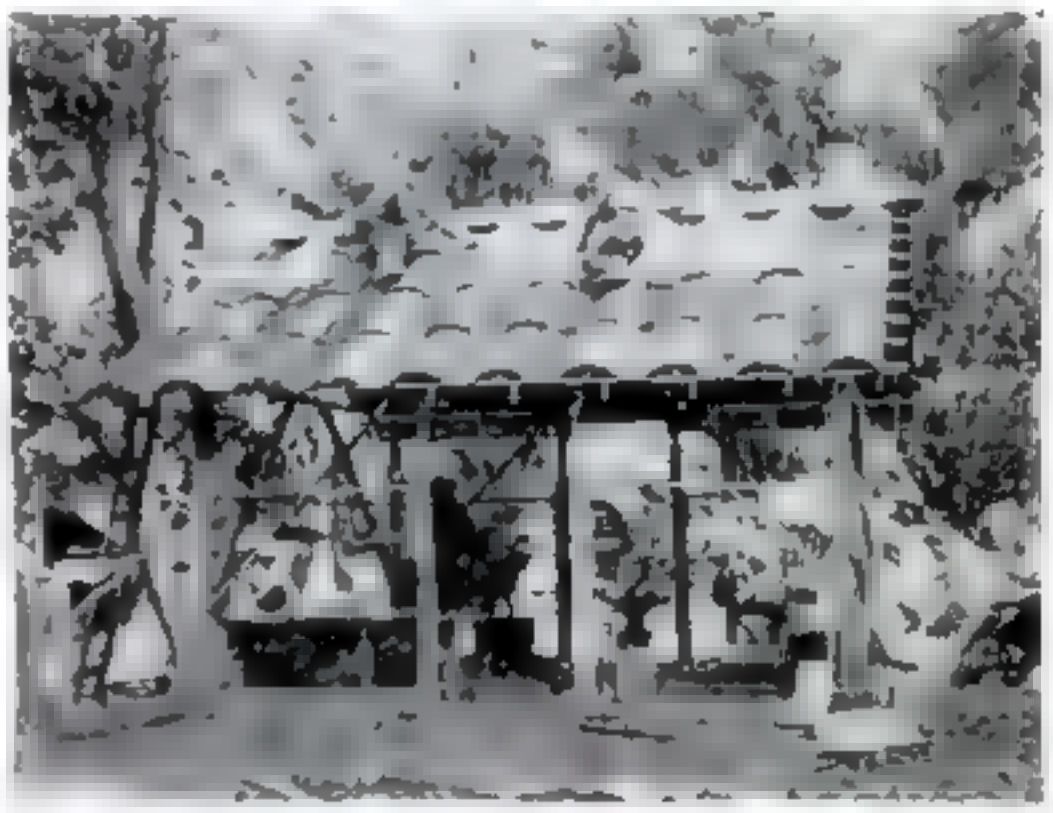
It was in the Solomons that the Seabees made history. Four hundred and fifty of them with 250 cases of beer landed on Guadalcanal and went in with the combat troops. Their ages ranged from 17 to 50 years; in the outfit were veterans of the first World War, college students, athletes, and artisans. Side by side with the Marines they fought off the Japanese snipers between working shifts, and sometimes spent the entire day hunting the enemy in the jungle. One sharpshooting Seabee got five Japs in a single day.

When equipment failed to arrive, they made the best of what they had. On Island X they erected a sawmill at the jungle's edge in order to build a mahogany bridge that will probably stand for years to come as a permanent memorial of Seabee ingenuity. Another bridge, connecting Henderson and Carney fields, is built on mahogany logs, some of them two feet in diameter, driven 17 feet into the ground. The decking is blood-red planking, 60 feet wide, and can carry two-way traffic. The natural color of the mahogany is blended with the blood spilled by tough Seabees who wouldn't take cover when there was a job to do.

The Navy needed a seaplane ramp built. It was partly a sea-bottom job and there was no diving equipment on hand. That didn't stop the Seabees. Out of gas masks and old inner tubes they manufactured a diving apparatus good enough to enable men to work for hours under water placing concrete slabs on the ocean floor. On the same job, jagged coral chewed up the tires on the earth-moving machinery, so the Seabees mixed palm-tree sawdust with cement, filled the tires with it, and kept the scrapers moving until the ramp was finished.

For five weeks one Seabee crew went without bread until baking ovens arrived, then they taught the natives a few things about cooking and the Marines about trad-

Mud and jungle fail to halt the Navy's Construction Battalions. Here Seabees dump rock from a beach to harden the soft New Guinea soil for road building as others in the outfit erect shelters



Improvisation and ingenuity go hand in hand wherever the Seabees take hold, as this tin roof in the South Pacific shows. It is made of partially flattened gasoline drums

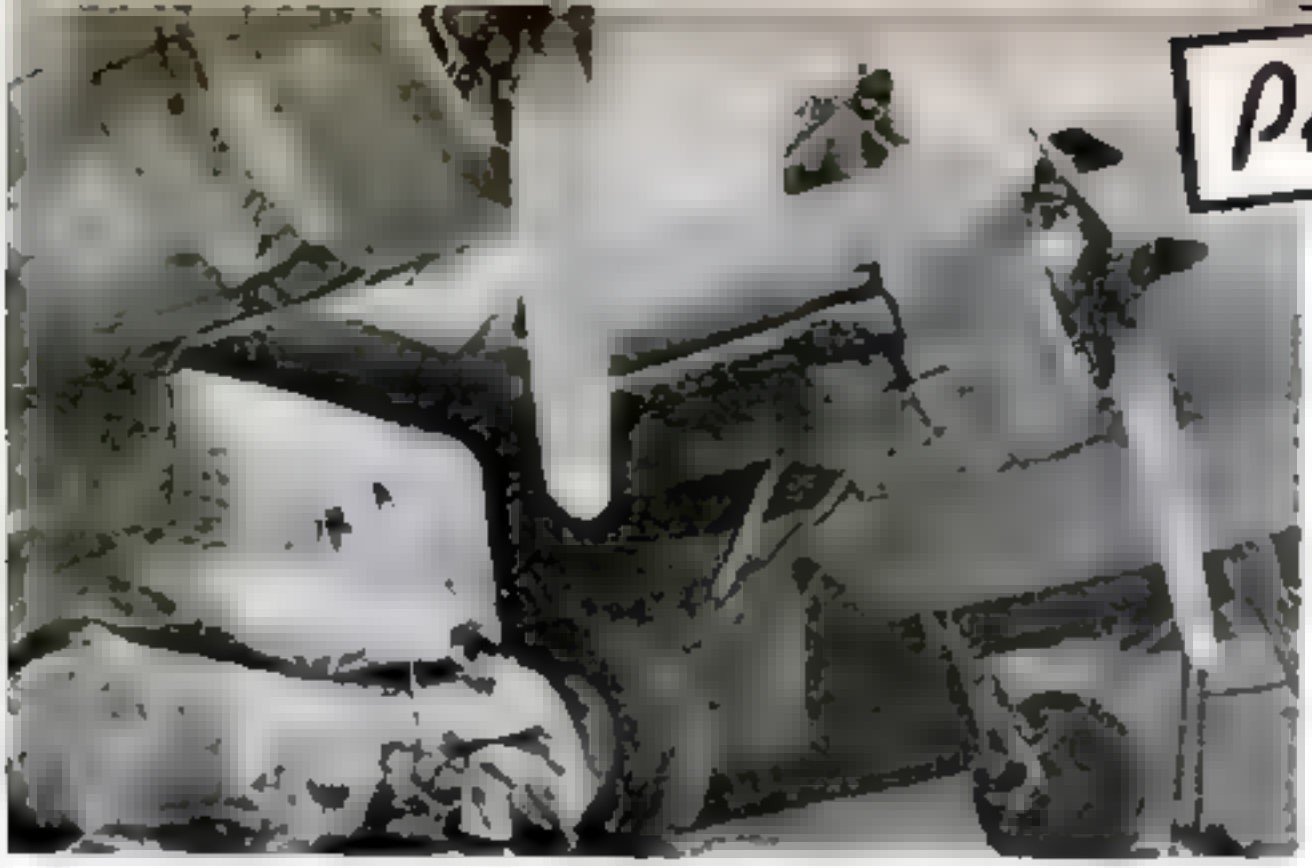
ing. A bottle of Seabee beer brought $5, or a good samurai sword. In British Samoa the natives now do a Seabee version of the Harlem jitterbug dance. One inquisitive Seabee, an ex-Marine with an eye to culture, cultivated the natives and unearthed an original Robert Louis Stevenson manuscript in a house in which the famous author once lived. He added to Stevensoniana the tale of a fireplace where Stevenson, on chill days, swept out the dying embers and sat upon the hot rocks to cook up some of his stories.

Romance also blossomed for some Seabees in Pago Pago, but they soon learned that you can't beat the game even in the South Pacific. The native damsels liked the Seabees even better than they liked the sailors and marines. Marriage was just a financial transaction, however, until the parting of the ways. Then it cost more—a down payment and a monthly allowance. And, to add insult to injury, local custom permitted the girl to marry again and again, drawing "compensation" and "allowances" from several husbands, although the ex-husbands were forced to remain "out of circulation" for the duration of their stay.

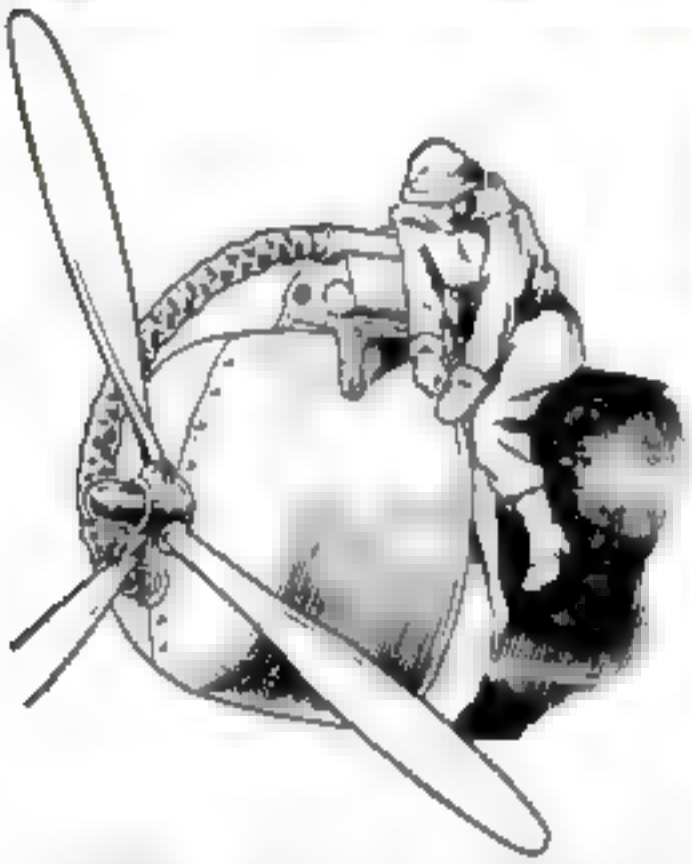
When the Guadalcanal gang found that they couldn't build an airfield on a certain spot, they transferred their equipment 18 miles overnight and built Carney Field. At one advance base where Marines were stringing barbed wire along the beaches to forestall Jap landing attempts, an enthusiastic Seabee, intent upon making the job easier for the Marines, shoved coconut tree stumps into the sea. He ventured out too far with his bulldozer and sank into the quicksand. The Marines suggested that the bulldozer be written off as a complete loss. "Hell, no!" said a Seabee officer, "that cat cost Uncle Sam $15,000." From 11 p.m. until daylight, while the tide was out, sweating and swearing Seabees labored until they finally salvaged the machine.

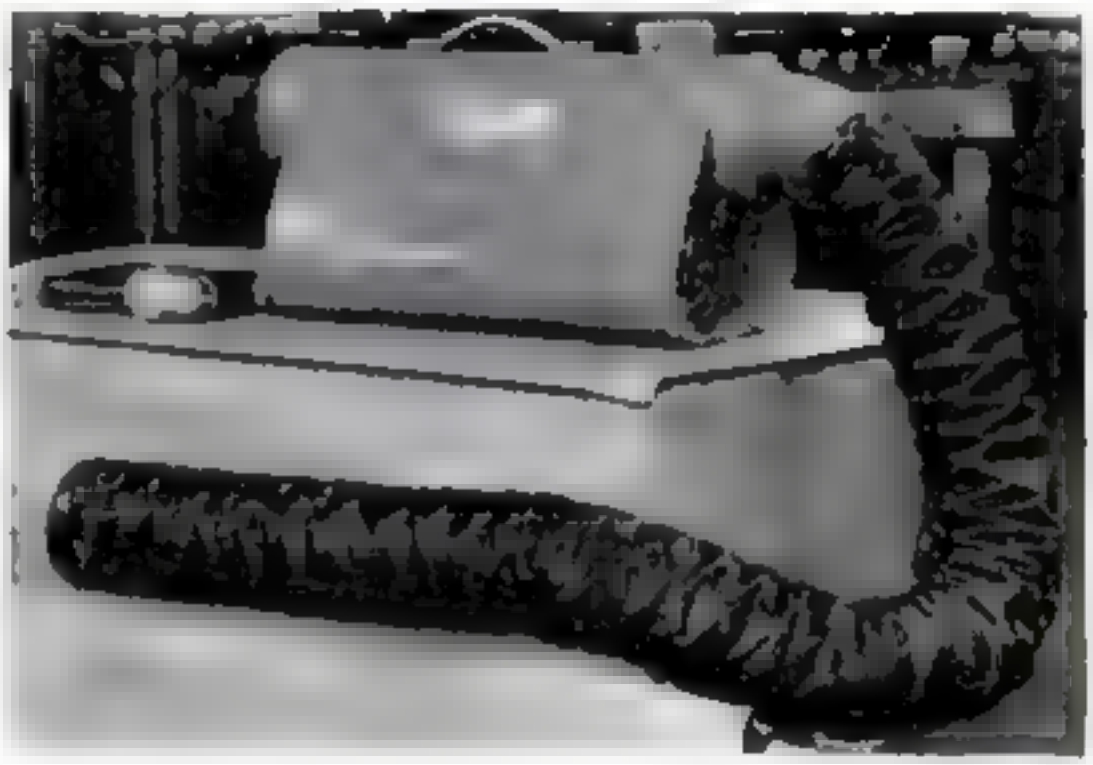
No usable equipment is ever scrapped by the Seabees. On our far-flung battle lines, spare parts are too scarce for anything to be wasted. Japanese dive bombers hammered hell out of a steam shovel on Island X; the cab was *(Continued on page 198)*

Plane News



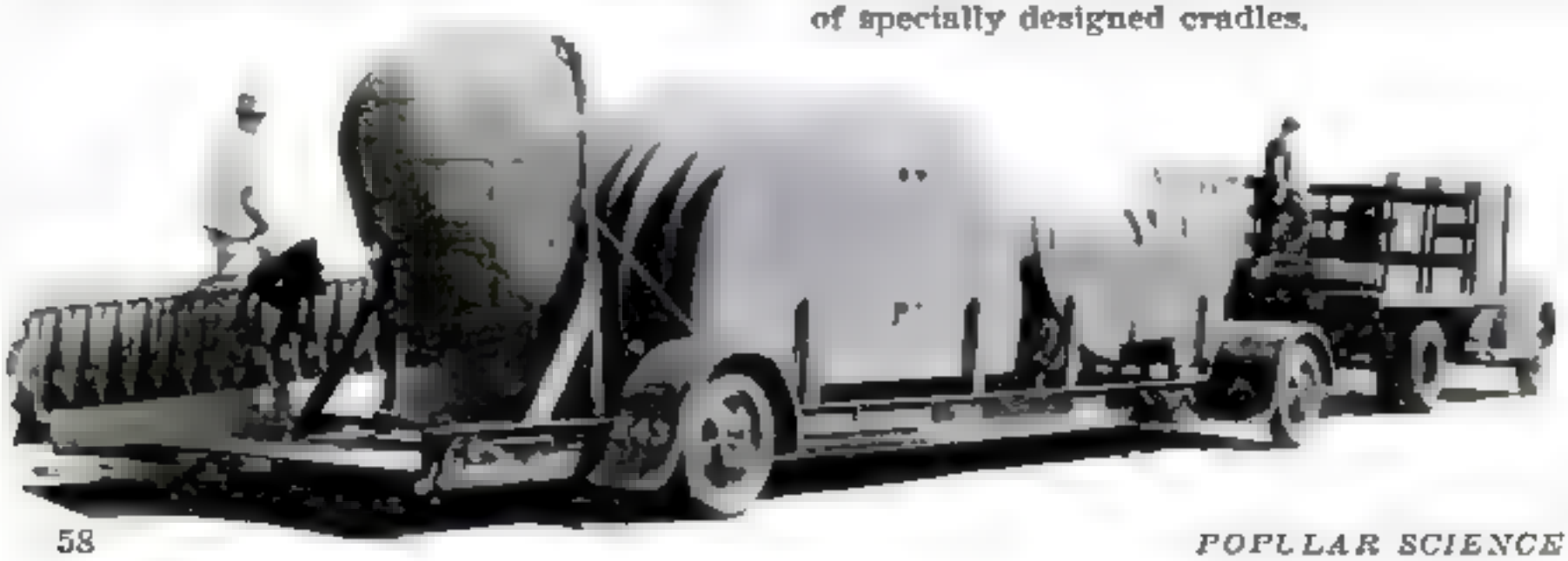
AIR-FILLED BAGS raise the wing of a Boeing Flying Fortress, somewhere in England, for testing of landing gear. Canvas bags spread the lift over a wide wing area, are easy to handle, and save precious metal. They are especially handy when the ground is uneven.





HANDY HOT AIR. This portable engine heater weighs but 38 pounds, burns gasoline, and produces 90,000 B.T.U. of heat an hour. Using 92 percent of heat units from burning gasoline, it is effective under all weather conditions. A small motor blower, using the standard plane power output, drives hot air through a flexible conduit to the engine hood. Developed by the York Oil Burner Co., it has proved particularly useful in starting seaplane engines, owing to its ease of handling by crewmen in rough seas. It can also be used to heat tractors, snow scrapers, and other heavy-duty equipment.

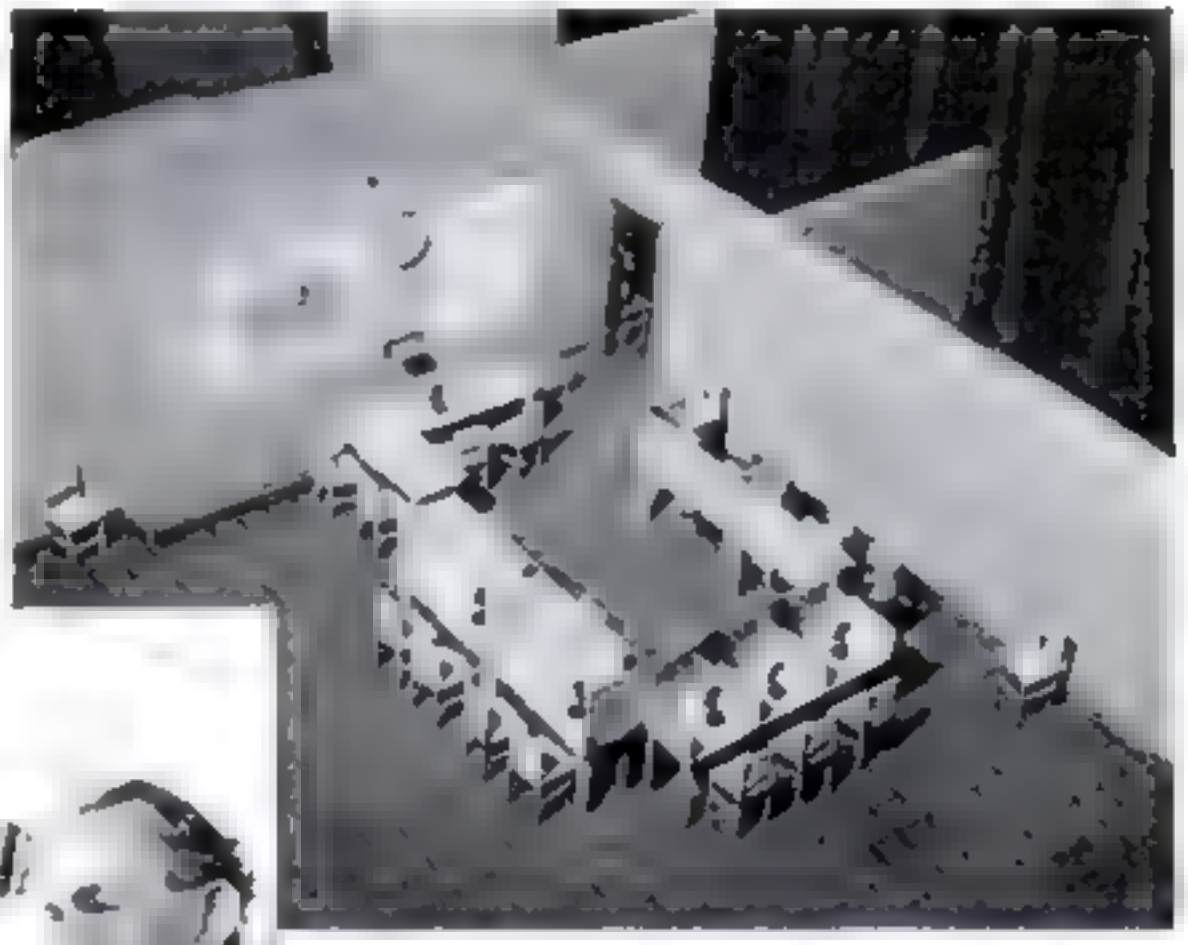
SPECIAL PARTS TRAILERS have been designed for easy moving of units of Consolidated B-24 Liberator bombers from one part of the factory to another. The trailer below is loaded with a B-24 nose section and fin and rudder units. The man is seated upon part of a wing's trailing edge. To prevent the possibility of friction and damage during transit, the heavier parts of the big bombers are carefully protected by means of specially designed cradles.

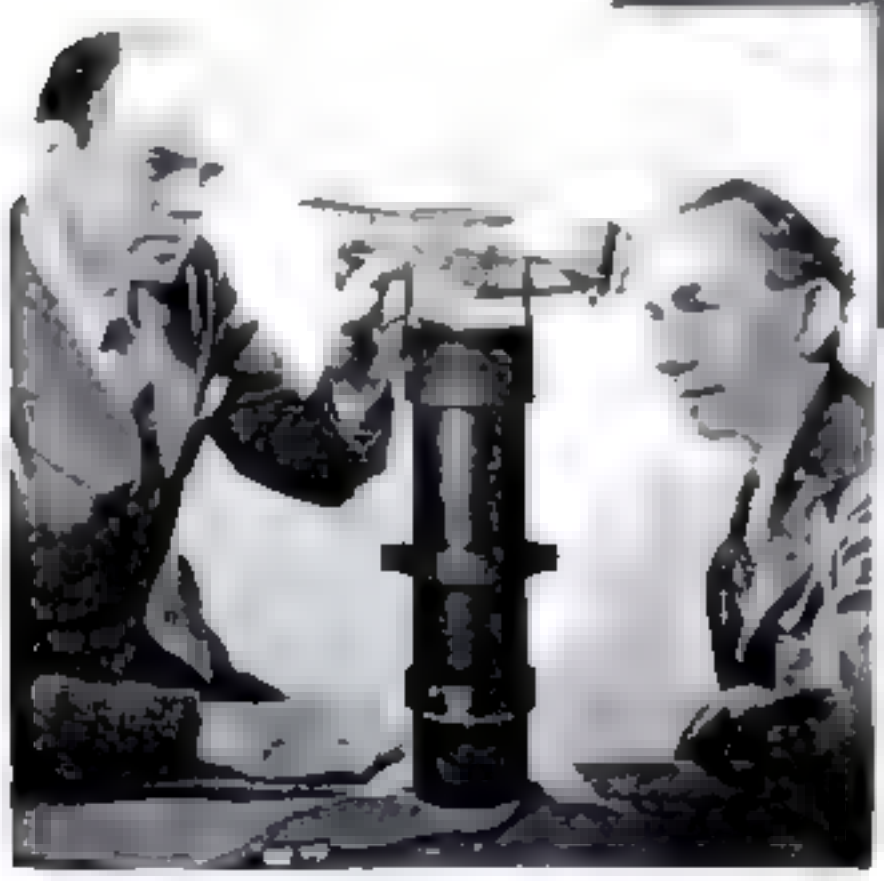


WEAKER SEX PROVES STRONGER than five men by using a new tire-bead loosening tool. Formerly it took five men six hours to break the huge tire bead from the rim. This Firestone tool can handle truck and aircraft tires up to 65 inches.

BUILT TO BE BURIED in airport runways, these heavy-duty lights can stand the pressure of 50 tons' dead weight standing on them. A Flying Fortress passing over exerts a 36-ton pressure, but Westinghouse builds 'em tough.

MODEL OF PERFECTION is this OCD control room made to a scale of one inch to a foot. Designed and built by two General Electric employees, it is used to help OCD units better to plan and lay out their offices. Walls fold up and the entire model can be packed for easy carrying from place to place.





A TRAINING GUN SIGHT designed by the American Optical Co. for the U. S. Navy duplicates the famous Spitfire combat sight at one-tenth the cost. A light at the bottom of the sight tube projects sight rings on a glass plate through which student sees his target. The sight rings are projected from film mounted between the light and lenses that carry it to glass plate at the top. The Navy is using the sight on laboratory trainers that simulate actual flying.

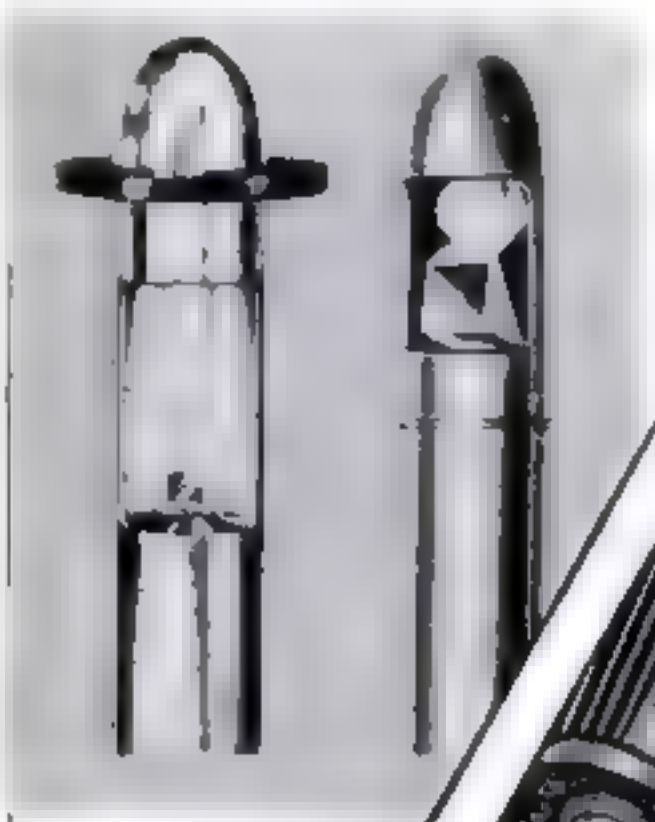
A RIFLE GRENADE, carrying a wallop that makes it a baby brother of the bazooka's rocket, is the Army's latest antitank weapon Springfield rifles, shelved in favor of the modern Garand, lob the grenades in much the manner of a mortar shell. Resting on one knee, which he places behind the gun butt, a soldier holds the barrel in his left hand, puts his foot in the sling and thrusts the grenade over a special muzzle fitting from which it is discharged.

WHO STABBED THE GOLF BALL? The scene was the 13th hole at the Baltusrol Golf Club, Springfield, N. J. The players were Charles A. Saitta and A. C. Fetzer. It was the former's turn to tee off. He took a lusty swing with a No. 1 wooden driver, and the ball rose with the burring sound of a startled cock pheasant. It landed 110 yards away. Examination disclosed that the tee had neatly stabbed through the cover. The mystified golfers pointed out that the ball was a pre-war Kro-flite—and so tough that you couldn't drive a tee into it with a hammer.

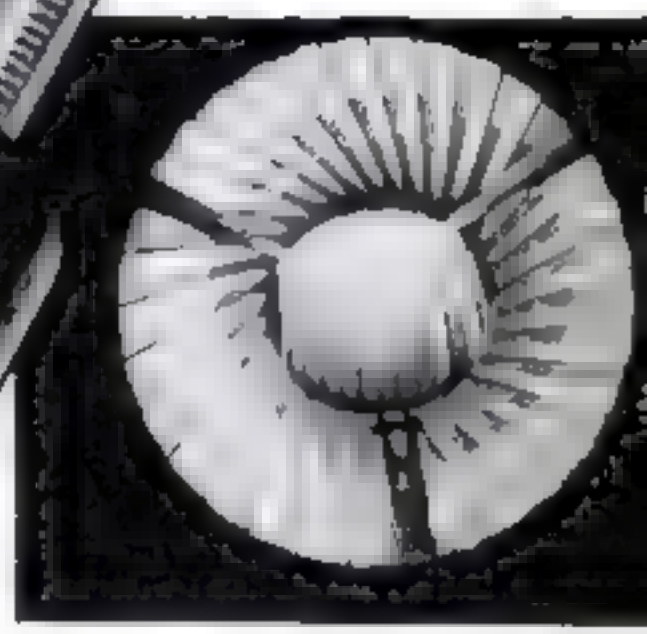
AN HONORABLE-DISCHARGE BUTTON, signifying his or her service to the nation, will be awarded by the War Department to every eligible person who has served in the Army during the present war. Although in the process of manufacture, the gold-plated plastic button is not yet available for distribution. Details will be made public as to how it may be obtained.

An inspector at a Chevrolet gun plant uses a borescope to examine the bores of 90-millimeter antiaircraft guns

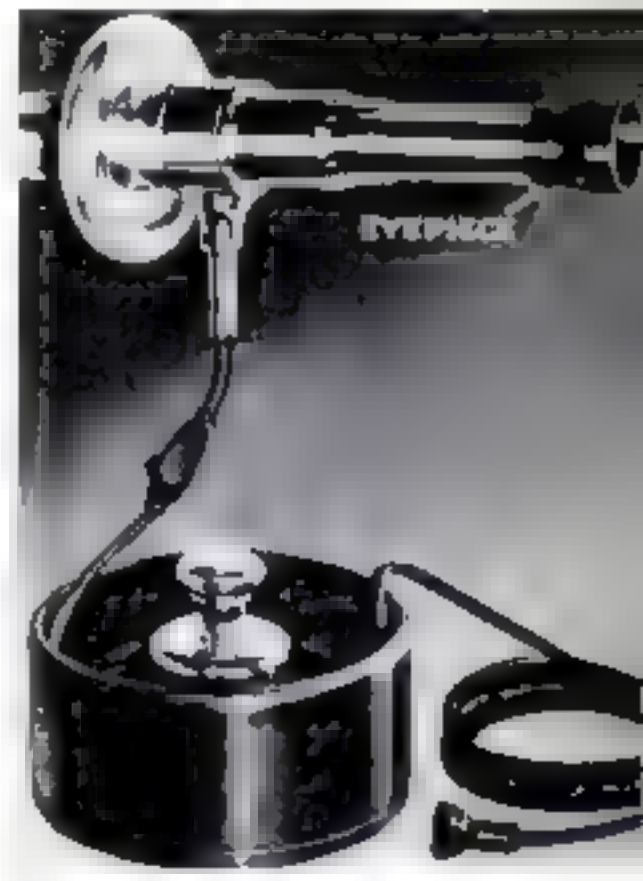
Two viewing heads are used: one, lower left, to study bore's circumference; the other, for precision examination of smaller areas



Above, a sectional drawing showing how the borescope is used to examine rifling and finish of a gun's bore



Above, rifling of 90-mm. antiaircraft gun as seen through Borescope. Below, transformer reduces voltage for the borescope's light



It Looks for Trouble in the Cannon's Mouth

AN ELONGATED microscope is doing an inside job on gun tubes, making sure that no interior flaws slow up shells in flight to the Axis. Known as the borescope and made by the Lenox Instrument Co., Philadelphia, this instrument probes back and forth in a gun bore, while the operator looks through the lens at every inch of the interior, checking on the finish and rifling. A lamp in the viewing head illumines the path of the instrument, and a rotating mirror reflects the images. Large Borescopes are often more than 25 feet in length.

Electroplating Mill

HUGE MACHINE, A MIRACLE OF ELECTRONIC CONTROLS, COATS STEEL BY A CONTINUOUS, HIGH-SPEED PROCESS

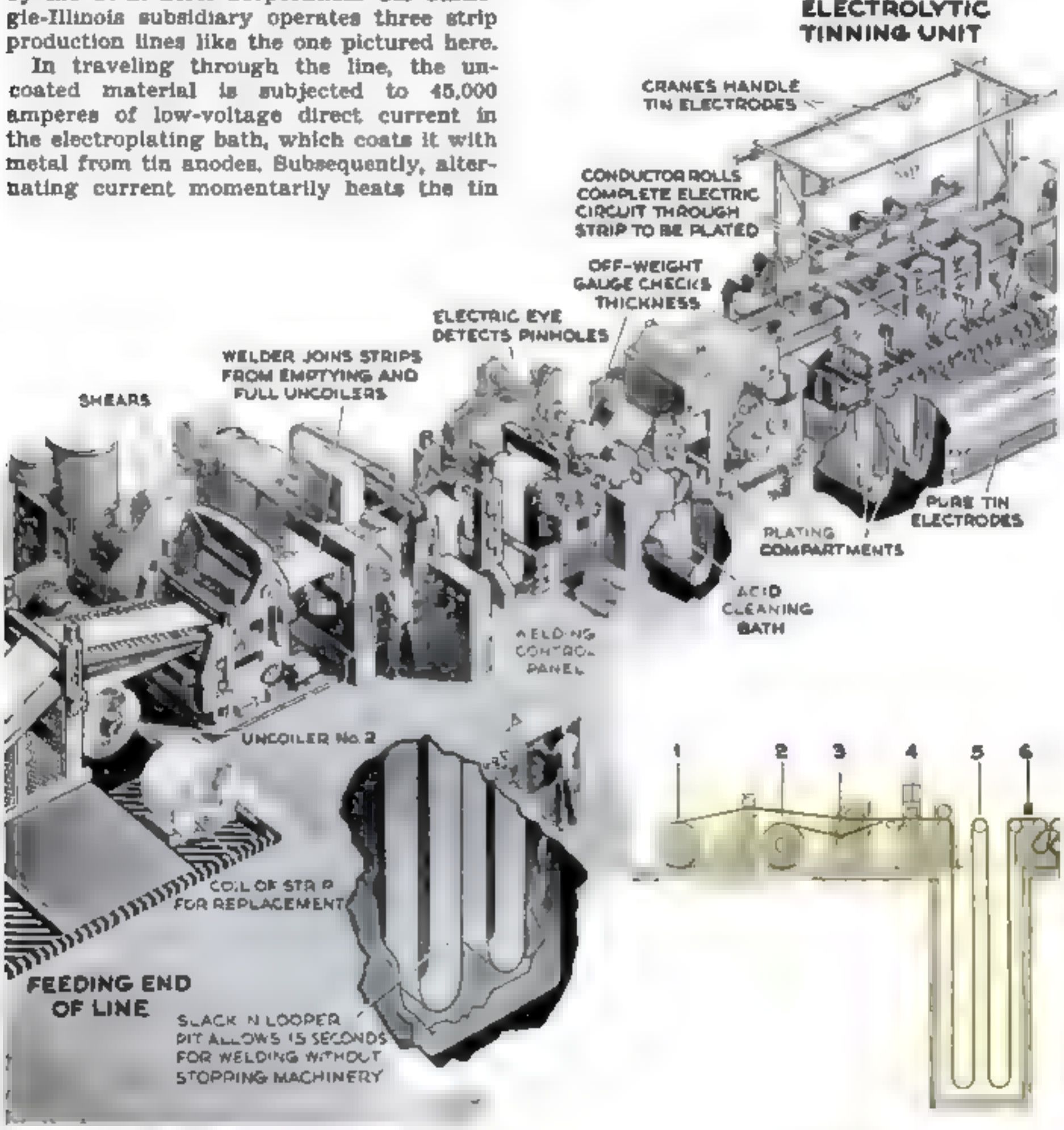
By Alden P. Armagnac

Drawings by B. G. SEISLSTAD

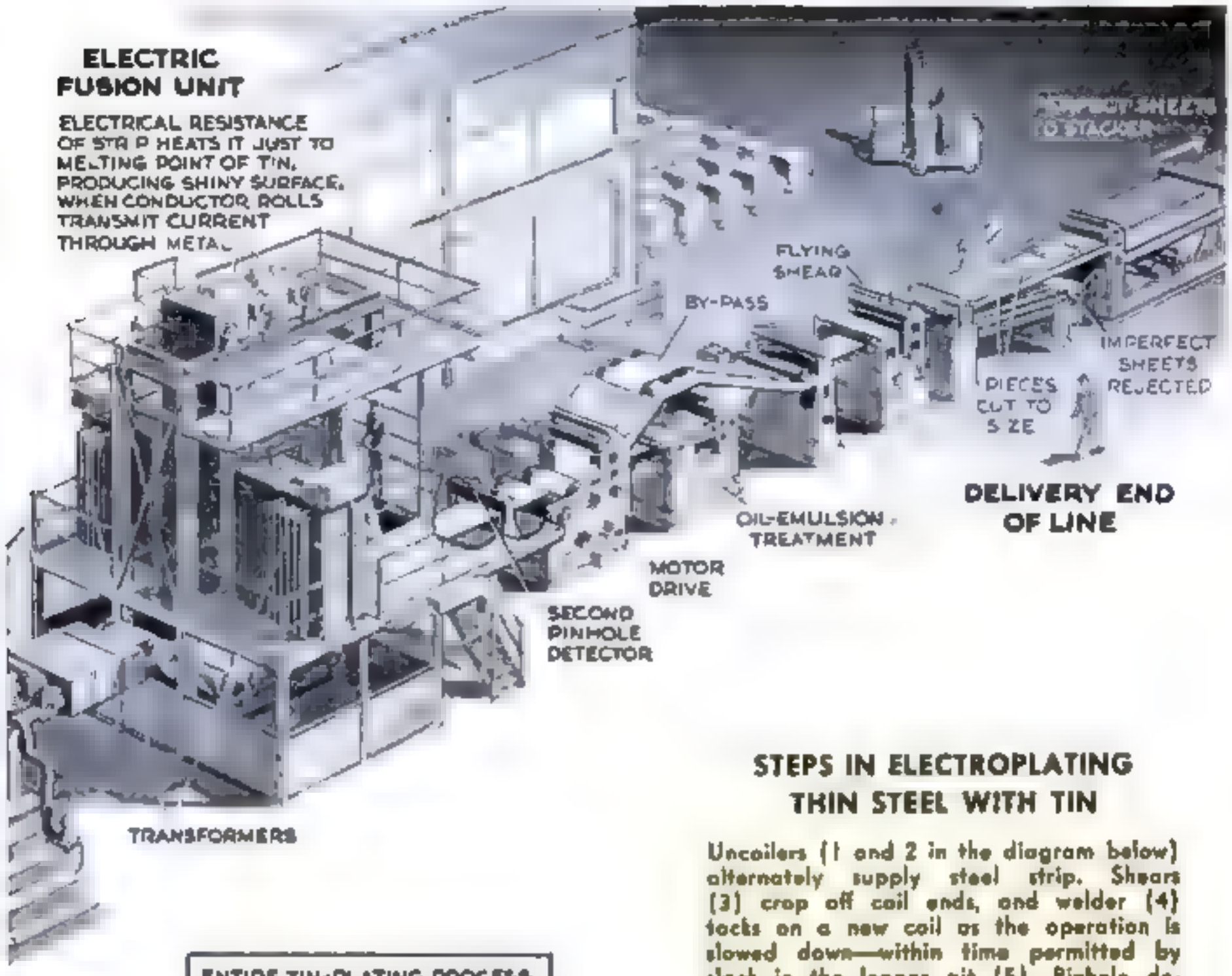
ELECTROPLATING steel with tin, instead of dipping it into a molten bath, now makes the war-scarce metal go three times as far. Since tests have shown the product highly satisfactory for tin cans and other coated articles, plants throughout the country are adopting the process, pioneered by the U. S. Steel Corporation. Its Carnegie-Illinois subsidiary operates three strip production lines like the one pictured here.

In traveling through the line, the uncoated material is subjected to 45,000 amperes of low-voltage direct current in the electroplating bath, which coats it with metal from tin anodes. Subsequently, alternating current momentarily heats the tin to its fusion point to brighten the surface.

An electric eye with timing attachment unerringly detects a portion of metal containing so much as a pinhole. The cut sheet containing the perforation is kicked into a rejection pile after it has traveled a circuitous course of 450 feet. A second pinhole detector checks on the first; a third electric eye counts the finished sheets; and a "feeler" gauge detects variations in thickness.



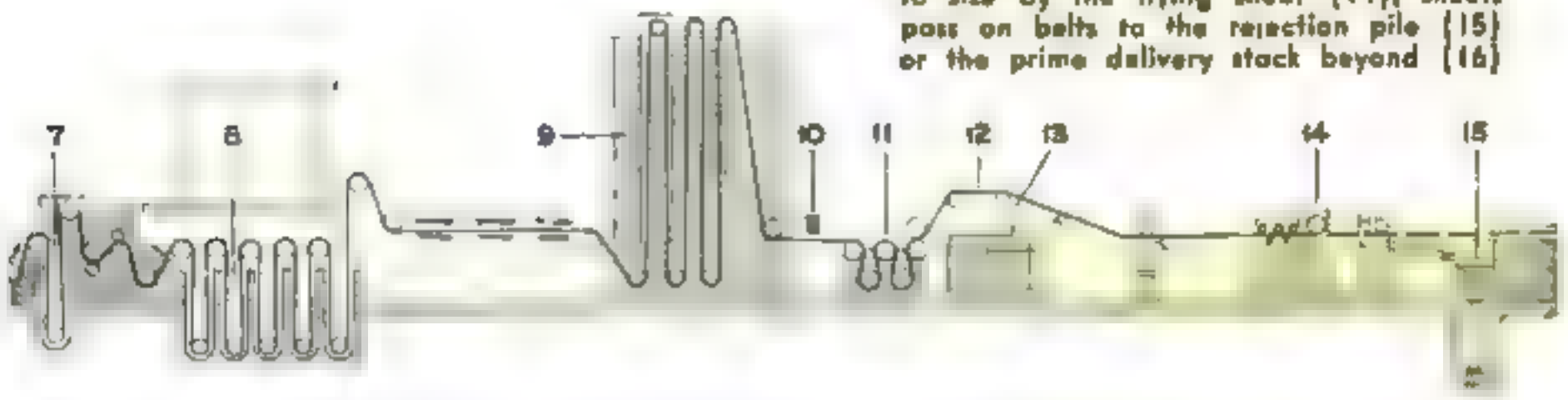
Stretches Our Precious Tin



ENTIRE TIN-PLATING PROCESS, FROM START TO FINISH, TAKES LESS THAN ONE MINUTE.

STEPS IN ELECTROPLATING THIN STEEL WITH TIN

Uncoilers (1 and 2 in the diagram below) alternately supply steel strip. Shears (3) crop off coil ends, and welder (4) tacks on a new coil as the operation is slowed down—within time permitted by slack in the looper pit (5). Pinhole detectors (6 and 10) automatically reject perforated sheets at the delivery end. An acid bath (7) cleans strip for tin-coating in the electroplating tanks (8). Electric fusion unit (9) turns the dull coating bright. Motor drive (11) propels strip, which may either by-pass (12) or go through (13) oil-emulsion treatment, according to the desired finish. Cut to size by the flying shear (14), sheets pass on belts to the rejection pile (15) or the prime delivery stack beyond (16)



Their Inventions Set Shipyard

Green workers do the impossible as former salesmen, farmers, and housewives devise tools to help build our cargo fleet.

By REINHART KNUDSEN

THERE were grave misgivings among the sober heads of Portland, Ore., when Henry Kaiser began hiring farmers, automobile salesmen, clerks, cowhands, butchers, and bakers to build ships in his three big yards. The yards, located only a few miles from each other in the Portland-Vancouver area, turn out Liberty ships, tankers, and escort carriers.

"You just don't make a skilled workman overnight," the old hands said. "There's going to be lots of trouble."

Nevertheless, the greenhorns were hired. They had to be hired because there weren't any trained workers left. Kaiser managers divided up every operation into its smallest component and tried to teach each worker just one small task that he could learn quickly and do well. They, too, had misgivings, but ships had to be built and this seemed the only way.

That was more than a year ago. Kaiser, as a shipbuilder, is now world famous. His greenhorn laborers not only learned the little tasks assigned to them, but came forth with suggestions of their own—suggestions that whacked great slices of time off ship construction.

Managers freely assign a great deal of the credit to a labor-management suggestion program launched in the yard in September 1942. The whole idea of the program was to invite workers to make suggestions of ways in which they could speed up their work, make their work easier, or contribute to the safety or improvement of working conditions in the yard. War bonds were offered as rewards. Primarily a move to improve morale, it was not expected to produce anything very tangible.

As the labor-management committee reviewed the achievements of its program for its first 10 months on July 1 of this year, it was amazed to find that in the three yards, employing approximately 85,000 workers, 8,695 suggestions had been turned in. Of these, 792 were acceptable and went into immediate use. During the 10-month period, 113 bond awards totaling $6,150 had been made.

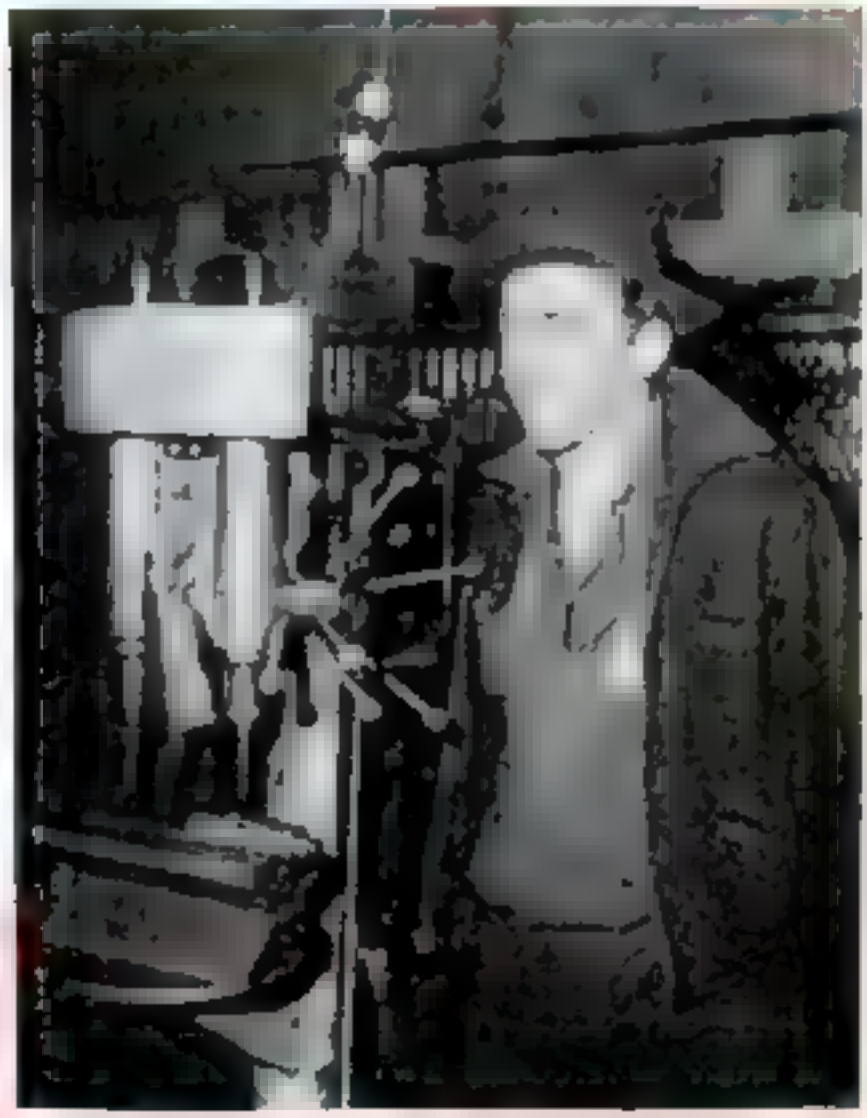
One worker developed a clamp to fair hatch-end beams that saves over 200 man-hours per hull. A former automobile-agency

MOLDS are now being used to speed the repairing of welding-electrode holders. Three shapes of molds are employed, one for each major part of a holder—lower jaw, upper jaw, and teeth. Placed in the proper mold, the part is held firm while it is being worked on. The inventor, Mrs. Ella Barkie, above, is a former Portland model, the mother of four children

Records

WELDING shell plates to the shell frames can now be done 50 percent faster with this **pneumatic pusher,** which quickly brings the plate and frame into proper alignment. Capable of 8,000 pounds' pressure, the pusher, consisting of a pneumatic cylinder and a ram, rides transversely on a beam, which can be moved the entire length of the assembly bay. With this two-way movement, a controlled pressure can be quickly exerted at any desired point over the area of the rig section. The device was designed by William Davis, right

BEVELING DECK PLATES was speeded up 40 percent when Ray Porcher, above, a former salesman from Rainier, Ore., devised this hand-cutting torch. With its head held in a collar supported by two small legs, the torch can be set at any angle with the aid of a calibrated dial. By running one of the supporting legs along the edge of the overlapping plate as a guide, the torch can be pulled along smoothly to make an accurate cut



DRILLING AND REAMING holes in universal joints can be done on this one machine, designed by Byron Mark Johnson, shown above. Intended primarily to increase the efficiency of these cutting operations, the two-spindled device by making it unnecessary to move the work from one machine to another to complete the operation is saving 16 man-hours per hull. Johnson is the shipyard's leading idea contributor

PLIERS designed by an electrician's helper now make it possible, in repairing welding-electrode holders, to extract and insert the springs and spring cups in a matter of seconds instead of minutes. This simple but timesaving device was made merely by brazing to the jaws of an ordinary pair of pliers clips to fit over the springs. The inventor is a typical "greenhorn"—Mrs. E. L. Norwood, who has three children, and who never held a regular job before entering the shipyards

A MOVABLE SUPPORT to which a portable drill press can be securely fastened so as to be kept square with a ship's deck, is the labor- and time-saving invention of W. P. Watts, who appears above. The support permits much more accurate work, eliminates much of the chance for drill breakage, and is said to be adaptable to many shipbuilding operations

SHRINKING THE PLATES of Kaiser's escort aircraft carriers is done in one third the ordinary time with this device, which puts four shrinking torches to work simultaneously. The torches are carried by a small cart made of pipe and scrap iron, and mounted on wheels for complete maneuverability. The idea came from an ex-restaurant operator, a former road-crew foreman, and a graduate of Dartmouth

man devised a bending machine to make special straps for electrical cable hangers. It saves about 500 man-hours per hull. Still another devised a bracket for holding welding degaussing channels that saves 140 man-hours per hull. A couple of South Dakota farmers teamed up to develop a simple jack-type deck puller that saves 4,250 man-hours per ship. A mother of three children, who had never held a job before in her life designed a pair of pliers for extracting and inserting springs and spring cups in Jackson "stingers," or welding-electrode holders, cutting what used to be a 10-minute opera-

PIPE BEVELING is done automatically with the machine shown at left, which saves 20,000 feet of pipe a month and reduces by 50 percent the man-hours required by former methods. Designed by George Allen and Ivan Chapman, left, the machine consists of a set of rollers synchronized by a motor with a cutting torch. As the pipe rotates, the torch burns in the bevel. The torch can be moved to make a cut at any point

tion to a matter of just a few seconds.

There is no counting the total number of man-hours saved by the multitude of little ideas, gadgets, and suggestions that this program has encouraged. Managers point out as significant, however, that even though the bottom of the labor barrel is being scraped, the average number of man-hours per Liberty ship at the Portland shipyards of the Oregon Shipbuilding Corporation has dropped from 523,469 to 349,-494 since September 1942.

During the first few months of the program only about six percent of the suggestions were acceptable. This proportion changed steadily until by June of this year 15 percent of all the ideas turned in were of the type that could be put into immediate effect, and some were outstanding.

Here's how the program works: A worker who gets an idea must put it in writing along with drawings, if these help in clarifying it, and then drop it in one of the many conveniently located suggestion boxes in the yard. The letter is picked up by the suggestion supervisor, who records it and notifies the worker that it has been received. Then he and the labor co-ordinator of the yard review the suggestion. If it merits technical consideration, it is referred to an operating department. From there it goes to the eight-man labor-management committee for final decision. This committee is composed of four men representing labor and four representing management. The ownership of each suggestion remains in the name of the contributing employee. He is free to sell, commercialize, or otherwise dispose of his contribution in any manner he desires. The Kaiser company merely uses his idea. Bond prize awards are given at each of the yards each month for the four best suggestions. Prizes are $100, $75, $50, and $25 in war bonds and are put up by the Maritime Commission. Where several men collaborate on an idea, the award is split among them.

PORTABLE DRILL PRESS. This drill cuts and reams holes in handrails three times as fast as could formerly be done by two men. Fastened to a jig, the drill is held firmly in position by two claws and a supporting arm. By eliminating vibration, the jig has considerably reduced breakage. The inventor, Sylvester Smith, shown above, is an ex-farmer who was working as a salesman in an Oregon furniture store prior to going to work in the Portland shipyards

How Army Air Forces chart 8,000 square miles a day

Superspeed Mapping

PUTS OUR FLYERS AHEAD

Simple new method plots world's most remote air routes . . . does 30 years' work in one . . . and gives United States a head start in the Air Age to come.

Photographs by WILLIAM W. MORRIS

THE science of charting, for generations keyed to the man on foot or on horseback, has finally caught up with the man in a P-38. Using a wholly new and simplified technique, the Army Air Forces in the past year have charted 3,000,000 square miles of rugged, remote country—an area that would have taken more than 30 years to map by old methods. This amazing achievement, an average of nearly 8,000 square miles a day, was made possible by the tri-metrogon process, perfected since Pearl Harbor.

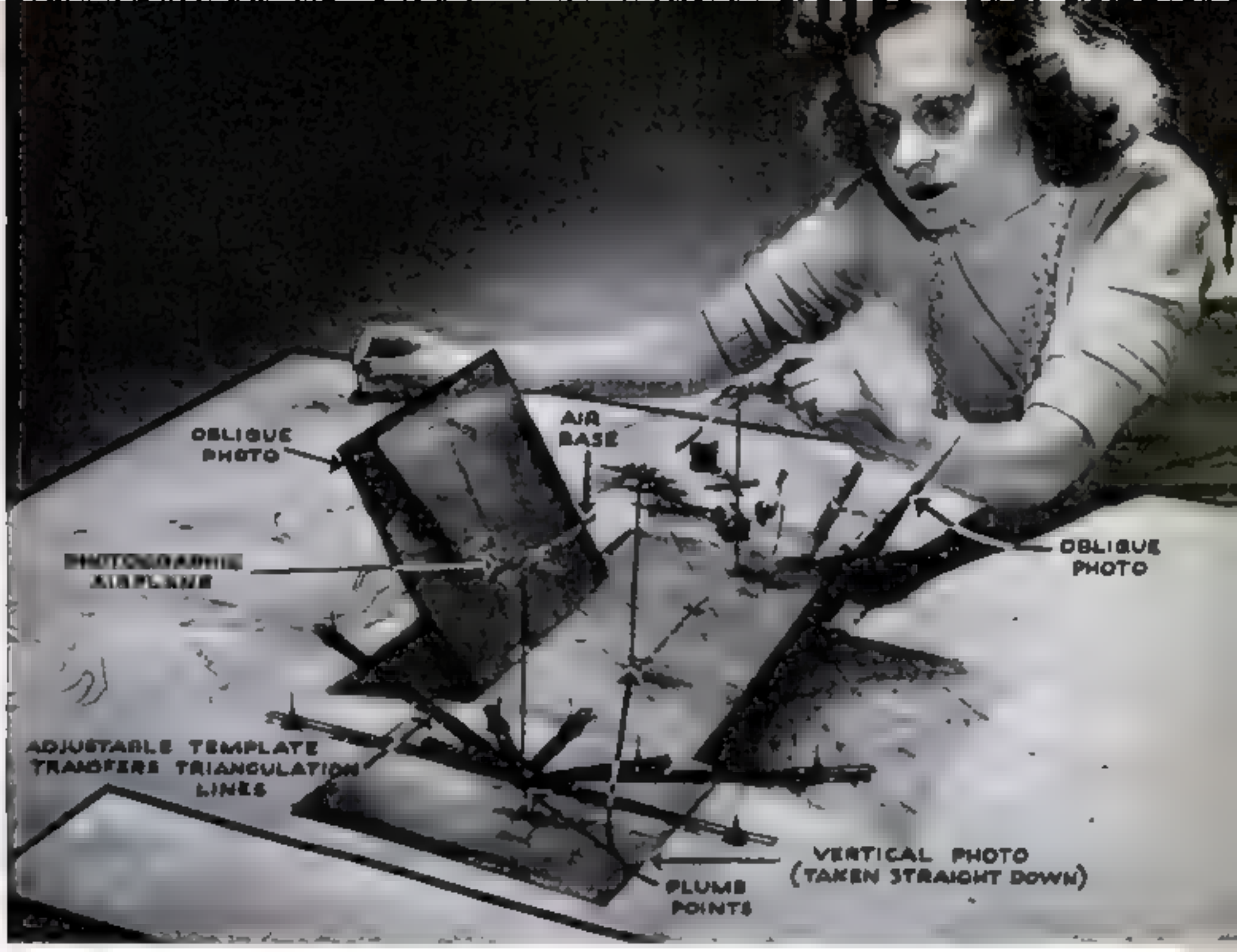
The process, named for the lenses in the compact three-camera unit with which the master photographs are made, was developed by Col. Minton W. Kaye, commanding officer of the First Photo Charting Group, Army Air Forces, and Lt. Col. Gerald Fitzgerald, chief of the Aeronautical Chart Service, formerly of the Alaskan Branch of the U. S. Geological Survey. It is so simplified that one airman can now photograph 20,000 square miles in less than half a day, and the transfer technique is so swift that not long ago a finished map of 89,000 square miles in Africa was produced just seven days after the photographs arrived at the compiling unit.

Aerial mapping is not new. It was used during World War I. But old methods were either fast and inaccurate, or accurate and slow. In more recent methods, highly complicated and expensive cameras, some of them taking as many as nine pictures simultaneously, were used. It took a year, however, to train a man to operate them; and after the pictures were made, a staff of experts was needed to transfer photographic

FIELD PARTIES LOCATE CONTROL POINTS . . . THEN PLANES

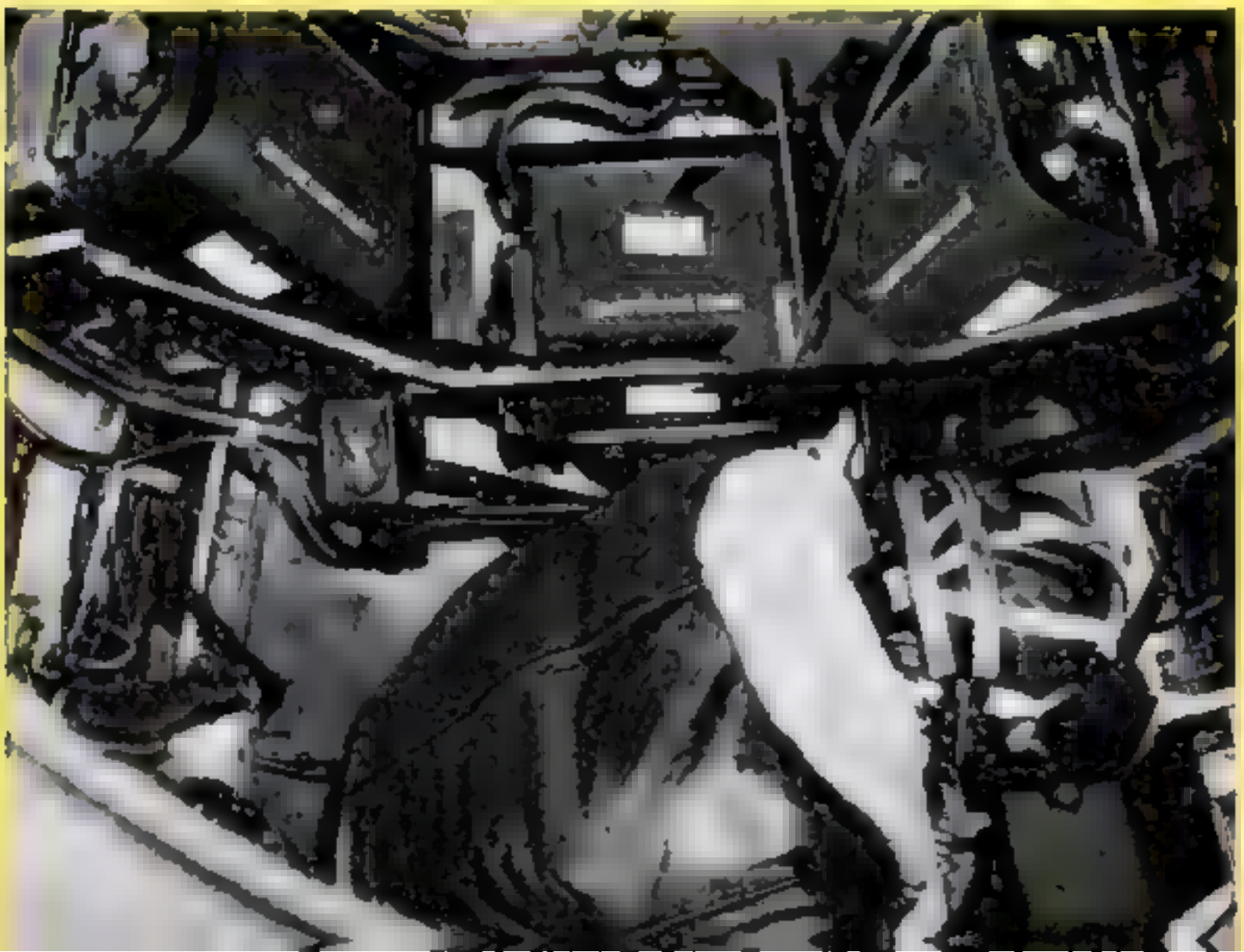
Although tri-metrogon charting is done almost entirely from aerial photos, geodetic control points must be located with the utmost accuracy by field parties consisting of from two to four Air Corps men. They are flown as close to these points as possible, then proceed as best they can. Control points are preferably spaced about 50 miles apart

Before camera planes are sent out, flight lines are indicated on the best available maps of the district to be charted, although these are often no more than guesswork sketches. The planes fly parallel courses about 25 miles apart. The camera unit in each consists of a vertical camera and two oblique cameras at 30 degrees below horizontal



Tri-metrogon charting at a glance. At regular intervals the plane takes three photos, one straight down, two obliquely. The threads indicate various angles used in projecting points to form the chart

AT 20,000 FEET DO THE CHARTING WITH SPECIAL CAMERAS



Inside one of the tri-metrogon charting airplanes a cameraman clad for high altitude flying, is adjusting the film magazines. The cameras (at top) have wide-angle lenses of six-inch focal length. They take a set of pictures every three miles, which provides sufficient overlap for an accurate assembly

detail to planimetric maps by slow, tedious processes. Tri-metrogon, by contrast, does an accurate job quickly and with a minimum number of specialists.

The easiest way to see how this is done is to follow a tri-metrogon project through from start to finish.

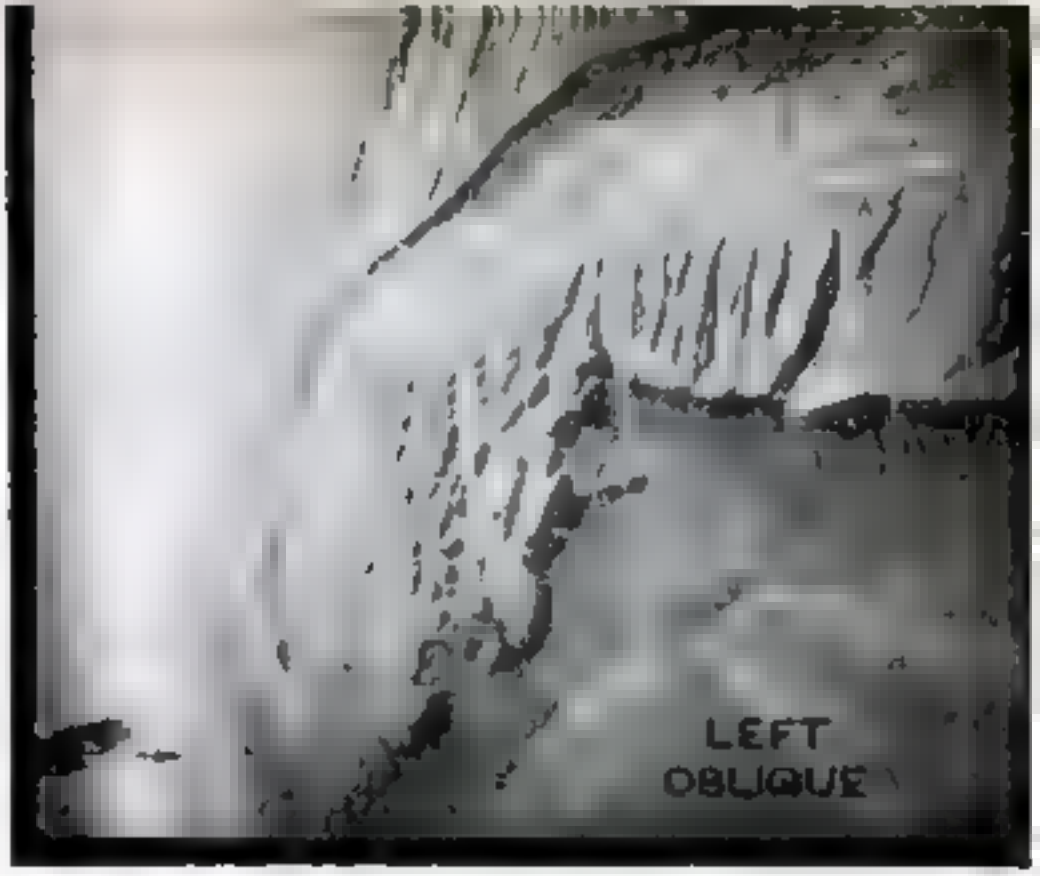
It begins with field work, as does any mapping job. The area to be charted is first laid out on the best available maps of the district, which often are no more than guesswork sketches. Flight lines are indicated and well-distributed geodetic control points are chosen—river junctions, promontories, lakes, islands. These points must be located with absolute accuracy, for they become the figurative corner posts on which the whole map will be squared.

Field parties, each consisting of from two to four Air Corps men, are sent out to establish astronomic control and make accurate descriptions of each point, so it can be identified on subsequent aerial photographs. Ideally, control points should be about 50 miles apart. To reach them is often back-breaking work, for although the field parties are flown as close as possible to the control points, they often have to go in by boat, by dog sled, or on foot. But on their work depends the ultimate geodetic accuracy of the map.

Field work, under the best conditions, is relatively slow. However, while it is going on, the aerial photographers begin their assignments. In the photographic planes, they fly parallel courses about 25 miles apart, considerably farther than in the old mapping methods. The tri-metrogon camera unit takes three pictures at a time, one vertical and two matching obliques, that cover a six-mile strip from horizon to horizon. The cameras have wide-angle lenses of six-inch focal length, and automatically take a strip of pictures every three miles, which provides sufficient overlap for final assembly. Photographic flights are made at approximately 20,000 feet.

When a flight area has been photographed, film is processed, and prints are made whenever possible in the field at the temporary headquarters of the Photographic Squadron. In some cases, the film is forwarded to this country for final printing. Field printing is desirable because it offers an opportunity to check photographic coverage. The negatives are titled with project number, date, location, roll, strip, and exposure number, and the prints are indexed.

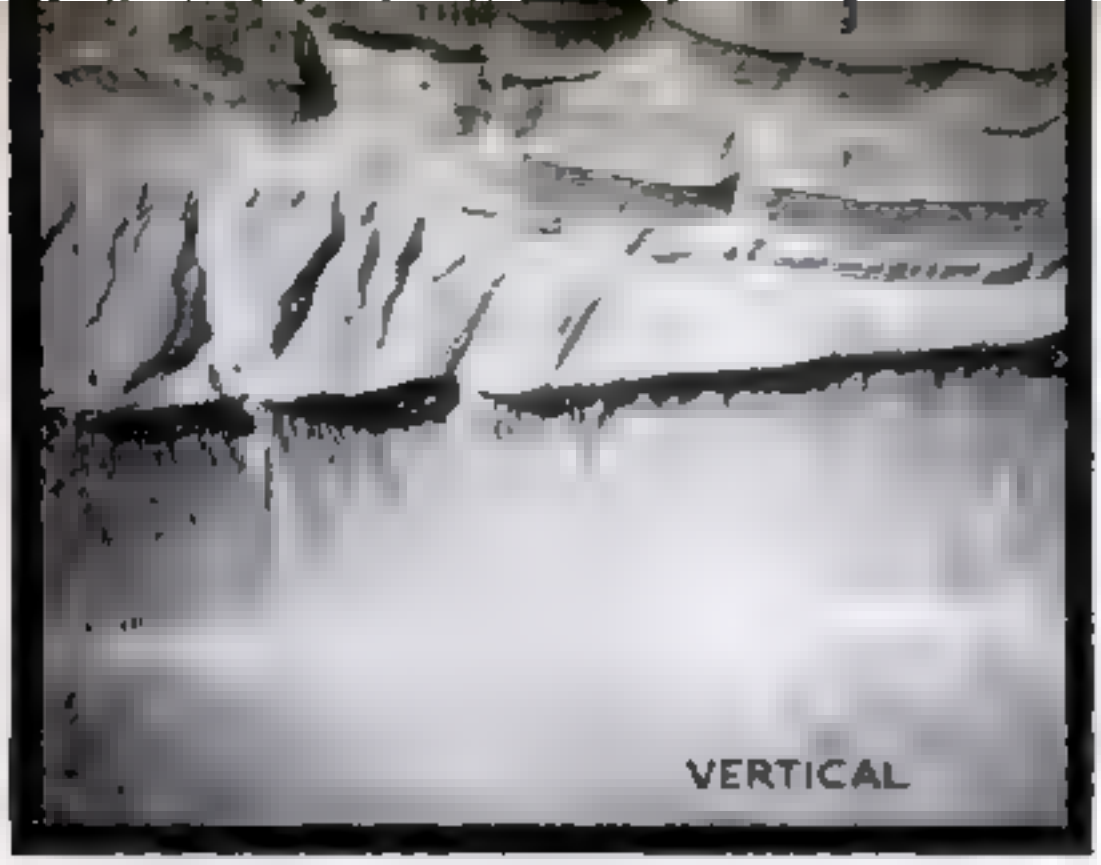
Two sets of contact prints are forwarded to the Army Air Forces Aeronautical Chart Service in Washington, which files one set for permanent record in the Central Film Library and forwards the working set to one of the three Army Air Forces Compila-



CONTACT PRINTS, made in sets of three, are nine by nine inches. Key points are taken from oblique photos with a special rectoblique plotter

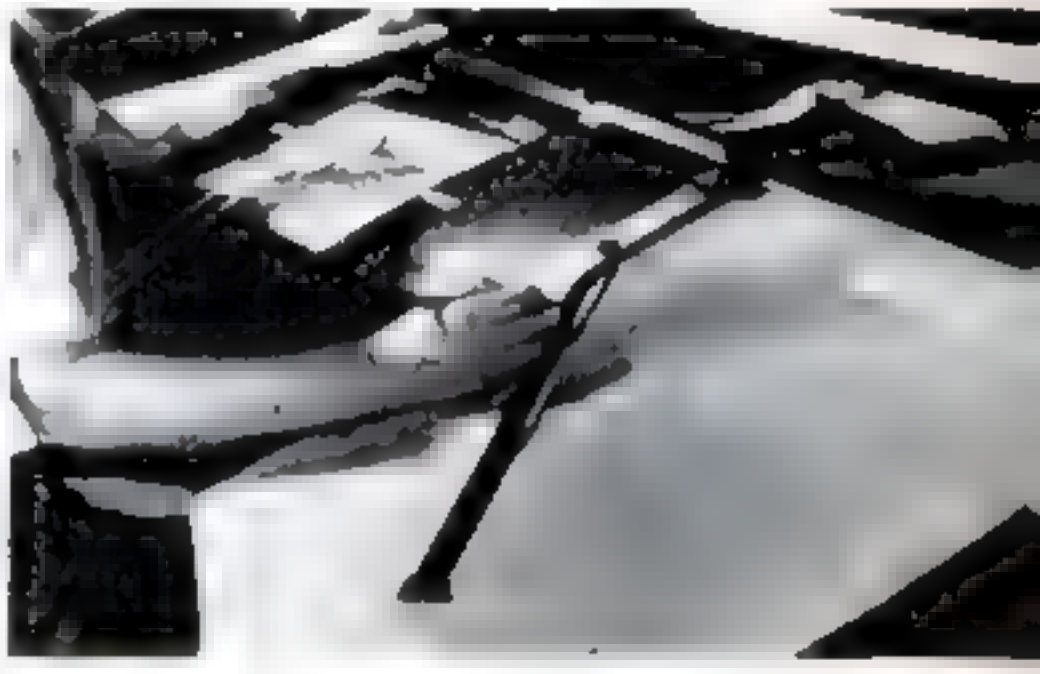
1 CHARTING STARTS, when the contact prints reach one of the three Compilation Units in the United States, by marking the position of each photo and its number on a master index map

4 When a set of paper templates is assembled, the intersections of similarly numbered lines represent detail points. A pantograph changes the scale as necessary. Then metal templates are made



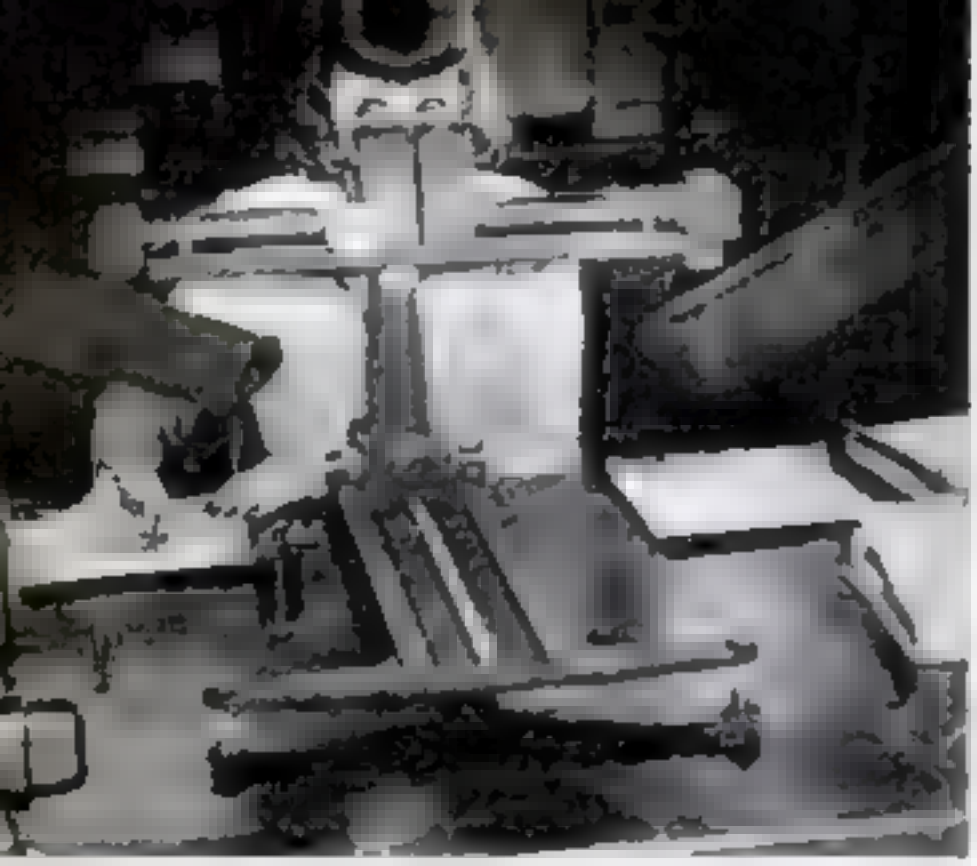
Horizon-to-horizon coverage is given by three overlapping pictures. The use of the six-inch metrogon lens at 20 000 feet gives a scale of 1:40 000 on the ful size vertical print (here shown much reduced). The air-line distance between the smal arrows at the extreme left and right is approximately 110 miles

2 Now it is necessary to indicate on the prints (with a circle inside a triangle) the geodetic control points established by field parties. Field notes and descriptions help to identify them



3 True horizontal angles are obtained from an oblique photo (left) by a pointer pivoted over the plumb point This controls the straight-edge for laying out a paper template (at right)

5 After the lines on the paper templates have been transferred to metal templates, the latter are laid down on a huge cellulose-acetate sheet which is to form the master-map base The template centers (below) represent lines of flight of the charting planes. Paper triangles show special geodetic control points. Pins are driven through the intersections of the rays the templates are taken up, and the base is marked



6 Meanwhile the contact prints go to sketchers who study them through magnifying stereoscopes. They select and outline in ink the principal geographic features which are to be transferred to the map

7 The acetate map base, with all its location points marked from the templates, is cut into three-foot strips; and detail sketchers, using a sort of camera lucida, draw in the details indicated on the photos

8 When reassembled the base map is compared with photos and other available data by checkers. Place names are then lettered in, contours and other data added

9 Contours are determined with a photoalidade, as on the facing page. Separate contour sheets are made (right) and printed in light colors on the finished map

tion Units—one in Washington, D. C., one in St. Louis, Mo., and one in Colorado Springs, Colo. Now comes "translation."

From here on, every operator on the job—there are 250 in the Washington unit, half of them women—has what amounts to a grandstand seat 20,000 feet above the area being mapped. With specially developed instruments they can see, in three dimensions, mountains and valleys that may never have felt man's footstep . . . can calculate the height *(Continued on page 188)*

Kodachrome by William W. Morris

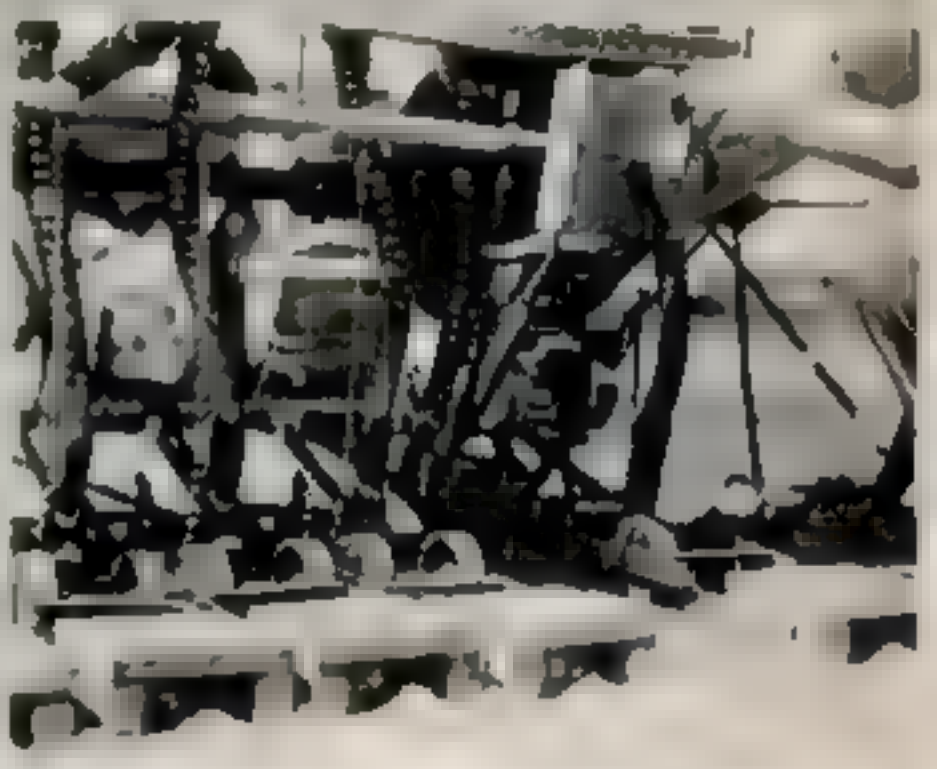
To provide a chart with contour details, which eventually will appear in color, this operator carefully studies an aerial photograph through the photoalidade. This instrument is a small, accurate telescope which, while placing the operator figuratively at a height of 20,000 feet above the earth, enables her to triangulate vertically any point on the chart

GROWING TREES FACTORY STYLE

SEEDLING tree "factories," with an annual production of millions of tiny Douglas firs, Sitka spruces, and western hemlocks, have been established by the West Coast Lumbermen's Association to restock Northwest areas that have been ravaged by forest fires. Prior to the planting of the seeds, special labor-saving machines plough a weed-killing gas six inches into earth, and then mix the earth with shredded peat to form soft seed beds. During their growth, the seedlings are "toughened up" for forest life by being alternately sprinkled and then allowed to dry in the hot sun. After they have reached a height of five inches, they are mechanically transplanted to the forests, where, if they survive fires and storms, they can be expected to grow to a height of 250 feet.

...ce of hand sowing, which allows the plants to grow in order they please, the seeds are laid in straight lines ermit a mechanical weeder to do its work between the rows

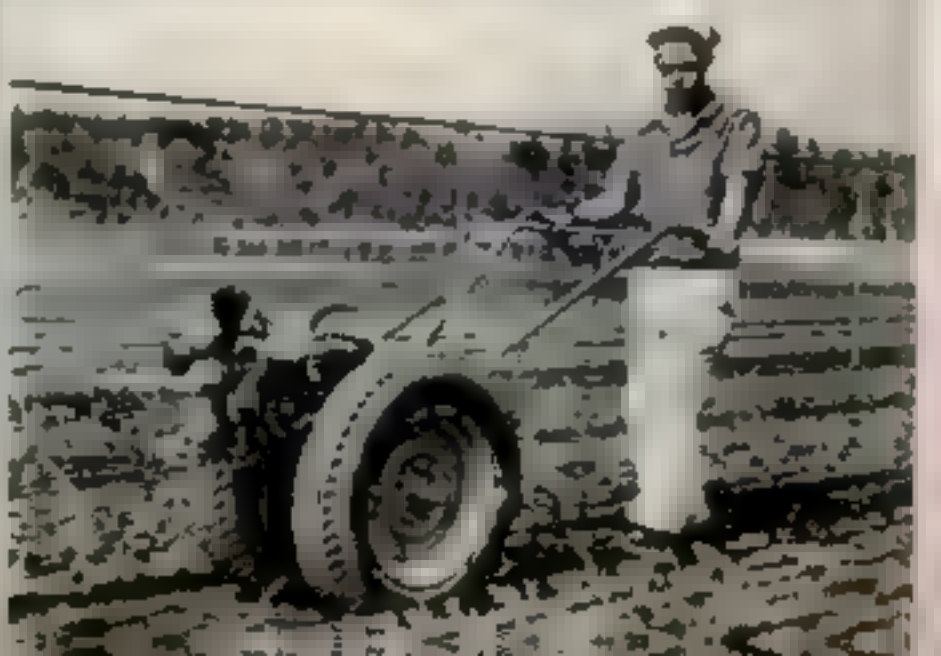
1 To sterilize the soil and thus reduce competition from weed growth, tear gas is pumped six inches into the ground through ...earth-ploughing pipes. Ground is allowed to stand for three days



3 Close-up of the mechanical feeder which lays the seeds in straight rows. Wooden sleds at bottom cover the seeds

2 Sterilized soil is then picked up by a tractor-drawn machine which sifts the soil on a shaking platform, mixes it thoroughly ...with shredded peat, and lays it down as a soft bed for seeds

4 A small two-wheel tractor is used to pull a pair of miniature offset cultivators between the narrow rows of seedlings



From the Enemy's Bag of Tricks

DEAD SNIPER. A Yank patrol, fired on by a Jap sniper hidden in a tree, sprayed the tree with bullets and saw a body drop. Continuing its advance, the patrol was again fired on. Again it replied—and again a body dropped. The third time it happened, the patrol investigated and found a sniper alternately firing and dropping dummies from trees by means of pulleys.

A FAKED DOGFIGHT is often staged by two Jap planes to trap a lone American flyer. Thinking to help out a comrade, the American plane dashes into the fray—only to find bullets suddenly spitting at him from both planes.

DEAD BIRD. A favorite ruse of Jap pilots is to put a plane into a spin and release plumes of smoke to make it appear that it has been hit. In this way a pursuing Allied plane is sometimes lured into the range of other Jap planes.

SO SOLLY. A supposedly surrendering Jap may be found with a special automatic revolver which, hidden under his tunic and pointing forward, can be made to fire 25 rounds by means of a wire running up his sleeve to his upraised hand.

BOGUS ISLES. Jap transports are sometimes covered with jungle foliage to make them appear as tiny islands. When set off by an incendiary, however, the highly inflammable covering "backfires" disastrously by turning the boat into a pyre for its crew.

The Facts About

Fighter-Plane Firepower

Our flyers meet their enemies in the air with faster-shooting, harder-hitting weapons.

By ARTHUR GRAHAME

Color Illustrations by JO KOTULA
Drawings by FRANK TINSLEY

THREE seconds isn't long—only as long as it has taken you to read this far.

But in the split-instant business of air fighting, three seconds is a long time—about the longest continuous stretch of time that a pilot of a single-seat fighter plane ever can hope to have an enemy plane within range of his fixed guns and in the ring of his sight screen. Usually he has considerably less than three seconds in which to make his kill. If he can get in a one-second burst, he calls it a good break, and even a fifth-second chance for a snap shot is something worth trying for

So, to be an effective weapon for a single-seat fighter, an aircraft gun must be able to hit *fast*. It also must be able to hit *hard;* the vital parts of Nazi fighters and bombers are sturdily armored these days. High velocity is an essential characteristic. Everything else being equal, a high-velocity gun has more penetrating power, longer range, and greater accuracy than a weapon of the same caliber which propels its projectiles at lower speed.

The best fighter-plane gun for air-to-air combat—fighter vs. fighter or vs. bomber—is the one which punches out the greatest number of the largest projectiles at the highest muzzle velocity in the shortest time. But because rapidity of fire decreases as projectile weight increases, the finest all-round fighter-plane gun must be a compromise between these desirable but conflicting characteristics.

The aircraft guns which best combine the qualities vital in air-to-air fighting are the 20-millimeter automatic cannon and the aircraft machine gun of half-inch or larger caliber. Although the British still are arming some of their Spitfires with 12—and some of their Hurricanes with eight—of their 1,200-shots-a-minute .303 caliber Browning machine guns and all the embattled air forces continue to use some similar rifle-caliber machine guns in combination with heavier weapons, the trend in fighter armament is strongly toward larger calibers and more power

Some Nazi and nearly all Japanese fighter planes still use as their principal weapon the 20-mm. automatic cannon with which the *Luftwaffe* started the war. This weapon is a short-barreled version of the Oerlikon antiaircraft gun. Its muzzle velocity—which, because of the design, can't be increased—is under 2,000 feet a second; its effective range is only about 500 yards; and its rate of fire is 10 shots a second. These old Oerlikons are definitely inferior weapons which are hopelessly outranged, outshot, and generally outclassed by our .50 caliber Browning aircraft machine gun and by both the American and British Hispano-type 20-mm. cannon

Late this summer, it was reported that some Nazi fighter planes were armed with new and extraordinarily efficient 20-mm. guns. When a specimen of this weapon, the Mauser M.G. 151/20, was captured, it impressed Peter G. Masefield, one of the soundest British unofficial experts, so strongly that, writing in the magazine *The Aeroplane*, he ranked it as the world's best aircraft gun. He gave its rate of fire as 800 shots a minute, and rumors had its muzzle velocity as high as 3,500 feet a second

There are several methods of rating the comparative merits of aircraft guns, but none of them is altogether satisfactory. The most-used comparison is weight of fire delivered in pounds of projectiles per minute—a misleading criterion because it takes into account only one of the gun's several characteristics. Masefield ranks the weapons by their muzzle horsepower, which he calculates from the rate of fire, the weight of the projectile, and the muzzle veloc- *(Continued on page 82)*

When the Mustang P-51 was found to perform as well at 50 feet as it did at 15,000, military designers decided to replace its machine guns with cannon so that it could deliver heavy blows in low-level attacks. The drawing at the right shows the plane, armed with cannon, blasting a truck convoy

PLANE	ARMAMENT	SHOTS PER SEC.	PROJECTILE WGT. LB./MIN.
SPITFIRE I	8—.303 cal.	160	220
HURRICANE IIC	12—.303 cal.	240	330
LIGHTNING	1—20 mm. 4—.50 cal.	68	547
AIRACOBRA	1—20 mm. 2—.50 cal. 4—.30 cal.	114	423
SPITFIRE IX	2—20 mm. 4—.303 cal.	43	650
CORSAIR	6—.50 cal.	75	580
LAGG 3	2—20 mm. 2—12.7 mm.	45	555
THUNDERBOLT	8—.50 cal.	112	688
HURRICANE IID	2—40 mm.	4	360
TYPHOON IB	4—20 mm.	43	650

THESE ARE THE "BIG FIVE" OF AERIAL

Nation	Gun	Caliber		Muzzle Velocity Ft./Sec.	Weight of Projectile	Max. Rate of Fire		
		In.	Mm.			Free	Syn.	
Germany	Mauser M.G. 151/20 auto. cannon	.7874	20	*3500	.25 lb.	800	600	
U. S. A.	Hispano-type aircraft gun—M-2	.7874	20	2850	.29 lb.	650		
Britain	British Hispano	.7874	20	2850	.25 lb.	650		
U. S. A.	Browning M-2 aircraft M.G.	.50	12.7	2900	800 gr.	850	600	
Germany	Mauser M.G. 151/15	.5906*	15	2800-2900	.19 lb.	950		

*Reported

FIGHTER ARMAMENT

PROJECTILE WGT. LB./MIN.	SHOTS PER SEC.	ARMAMENT	PLANE
194	24	2—12.7 mm.	MACCHI C-202
227	80	1—20 mm. 4—7.9 mm.	ZERO S-00
256	35	2—20 mm. 2—7.7 mm.	ME 109E
339	88	2—20 mm. 4—7.9 mm.	ME 110-C5
231	33	2—.311 cal. 1—15 mm.	ME 109F
390	60	2—15 mm. 2—7.9 mm.	HENSCHEL 129
431	70	2—15 mm. 2—7.9 mm.	ME 210-A1
606	58	4—20 mm. 2—7.9 mm.	FOCKE-WULF 190
681	59	2—7.9 mm. 3—20 mm.	ME 109G

GUNS

	Projectile Wgt. In Lb., Min.	Shots Per Sec.
	150-200	10-13.3
	188.5	10.8
	162 5	10.8
	68 5-97.1	10-14
	143	15.8

THESE ARE THE AIR'S TOUGHEST FIGHTERS

P-47 THUNDERBOLT
Eight .50 caliber machine guns

SPITFIRE IX
Four 20-millimeter cannon

P-51 MUSTANG
Four 20-millimeter cannon

MESSERSCHMITT 109F
Four .311 caliber and one 15-millimeter machine gun

FOCKE-WULF 190
Four .311 caliber machine guns
Two 20-millimeter cannon

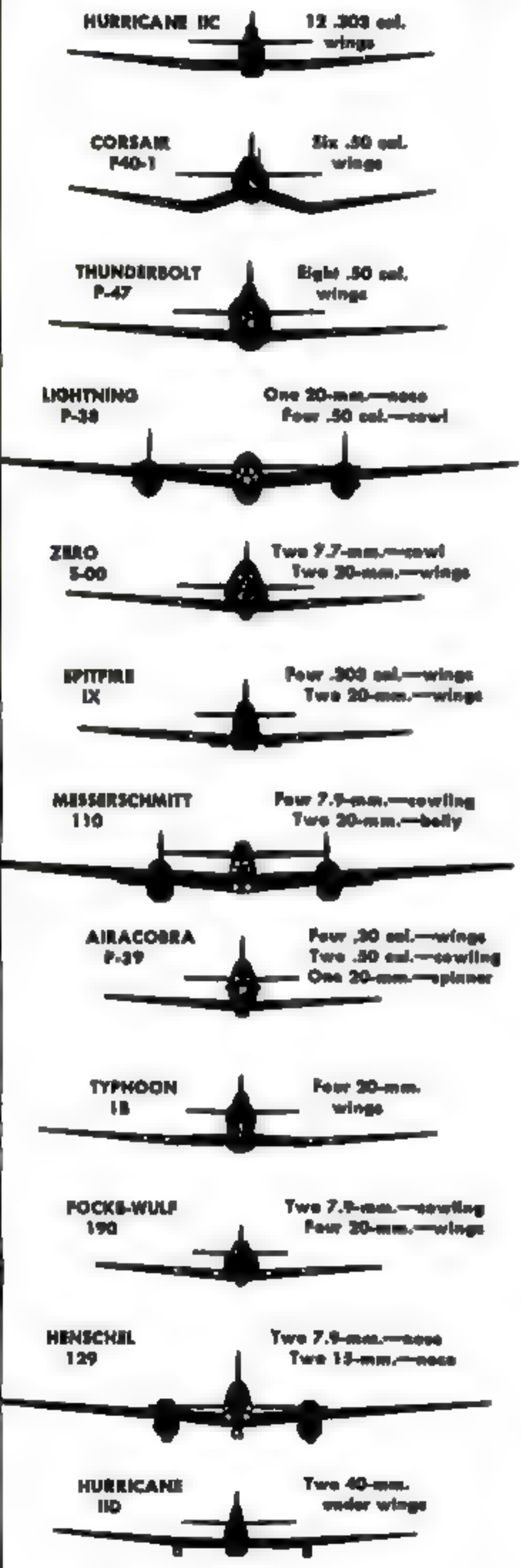
The fight for aerial supremacy isn't limited to the sky. An equally intense struggle goes on in production—to equip planes with guns that threw the greatest number and weight of projectiles with the greatest velocity in the shortest time. Although many planes still use rifle-caliber guns, the trend is strongly toward armament of higher caliber and more power.

P-38 LIGHTNING
Four .50 caliber machine guns
One 20-millimeter cannon

F4U CORSAIR
Six .50 caliber machine guns

ZERO 5-00
Four .311 caliber machine guns
One 20-millimeter cannon

TYPES AND POSITIONS OF FIGHTER ARMAMENT



ity. With the data he had, he was fully justified in putting the Mauser 151/20 at the top of the list. On paper it seemed definitely, if slightly, superior to any United Nations aircraft weapon.

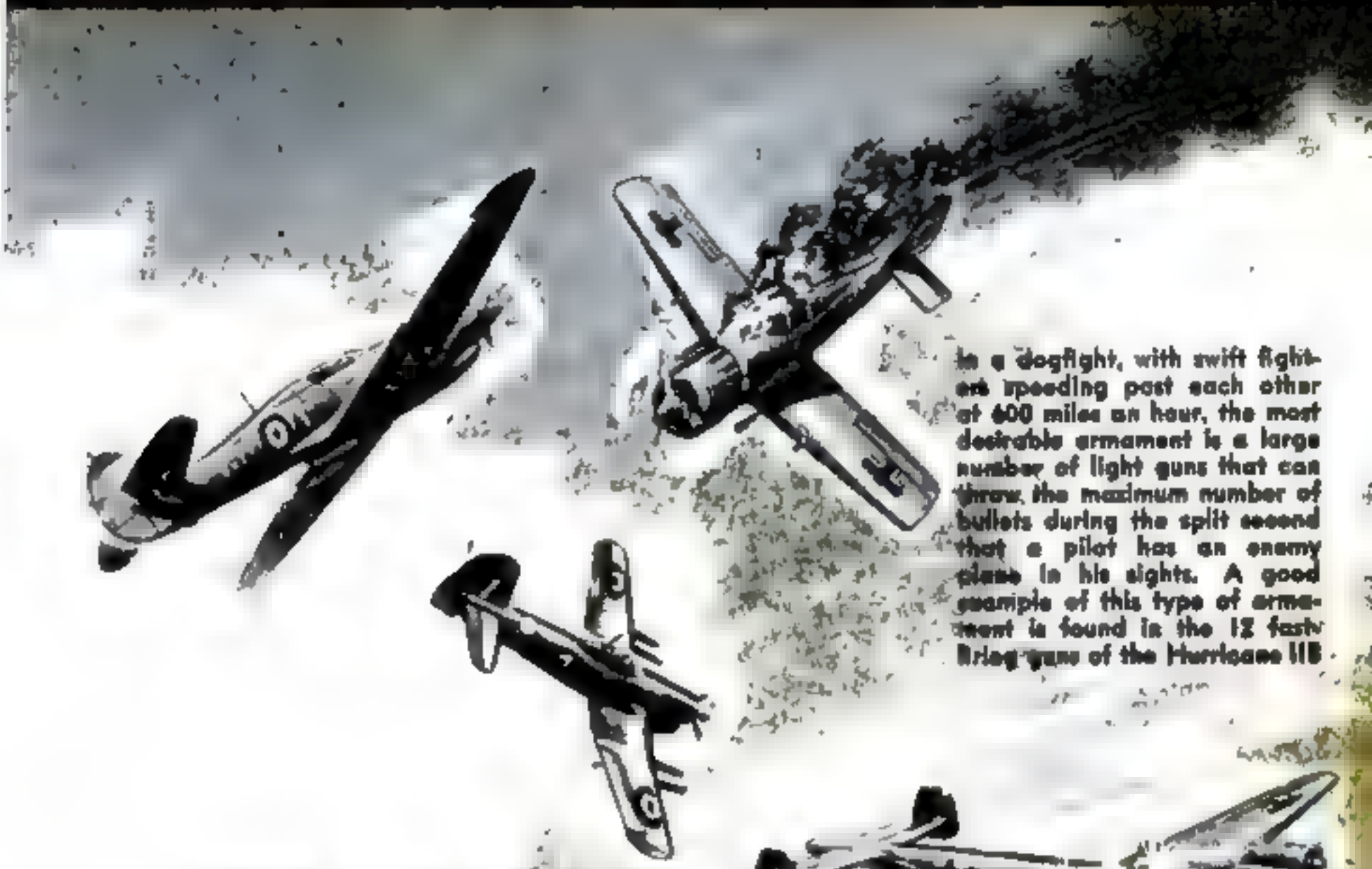
Like the much-touted German 88-mm. antitank gun, the Nazis' new aircraft gun is a good weapon which has failed to live up to its too-good advance notices. Firing tests of a captured Mauser showed that its muzzle velocity is a mere 2,300 feet a second. Its rate of fire is about the same as that of American and British 20-mm. aircraft cannon, but it definitely is inferior in range and hitting power. It is more prone to jam than are our guns, and—like many German weapons—it isn't well designed for large-scale production.

Both the American and British 20-mm. aircraft cannon are descendants of the original Hispano-Suiza. Each fires explosive shells which weigh a little over a quarter pound, at the rate of about 700 shots a minute. They are of the same weight, 135 pounds with their mounts—15 pounds heavier than the German 151/20.

The normal effective range of the .50 caliber Browning and of the American and British Hispanos is the same, about 800 yards, but the Browning has the great advantage of being able to "reach out" farther when necessary, and if the pilot is a good enough shot it will score deadly hits at well over 1,000 yards. The Hispano's .29-pound supersensitive-fused shells are explosive. The Browning is just as deadly. Its armor-piercing bullets have higher striking velocity, and its incendiary ammunition—considered the most efficient ever produced anywhere—does its job so well that our pilots know that one or at most two hits on an enemy

To be effective, bullets from aerial guns must hit hard. A projectile traveling at, say, 2,700 feet a second might not penetrate armor, while the same projectile with no increase of weight might bore through at 3,500-foot-second velocity

GOOD ARMAMENT IS THE RIGHT GUN FOR EVERY TARGET



In a dogfight, with swift fighters speeding past each other at 600 miles an hour, the most desirable armament is a large number of light guns that can throw the maximum number of bullets during the split second that a pilot has an enemy plane in his sights. A good example of this type of armament is found in the 12 fast firing guns of the Hurricane IIB.

In attacking a comparatively slow-moving target, such as a bomber, the need for fast-firing guns is not so great because the firing intervals can be made longer. Rapidity of fire, therefore, can be well sacrificed for the more powerful projectiles required to smash a bomber's heavy structure. The Typhoon, with four 20-mm. cannon, is ideal for this type of combat.

In firing on such targets as trains, tanks, and traffic, the firing intervals can be made even longer, but only projectiles carrying a very heavy punch will prove effective. The 37-mm. cannon of the Airacobra was especially designed for this kind of attack.

plane's gas tank means a goner Jerry or Jap. The Browning fires 14 shots a second to the Hispano's 11½; and its higher velocity speeds its bullet 1,000 yards in a quarter second less than it takes the Hispano's shell to travel that distance—a saving of time that may mean the life-or-death difference between a hit and a miss when the target is an enemy plane flying between 500 and 600 feet a second. One of the salient characteristics of the Browning is its remarkable dependability. In the Tunisian campaign about 85 of our P-40-type fighters fired a total of 25,000 .50 caliber armor-piercing and incendiary bullets (*Continued on page 186*)

Miniature Battlefields

SAVE LIVES IN INVASION

Dioramas and scale models teach our soldiers how to win when they meet the real thing

By JACK O'BRINE

EXPERT use of natural concealment and camouflage safeguards the lives of our troops in this global war. Beforehand knowledge of difficult terrain along invasion beaches and other prospective battlegrounds makes it possible for our military leaders to hit the enemy hard with minimum loss. Our fighters knew what they were up against in the Solomons, North Africa, and Sicily. Victories resulted.

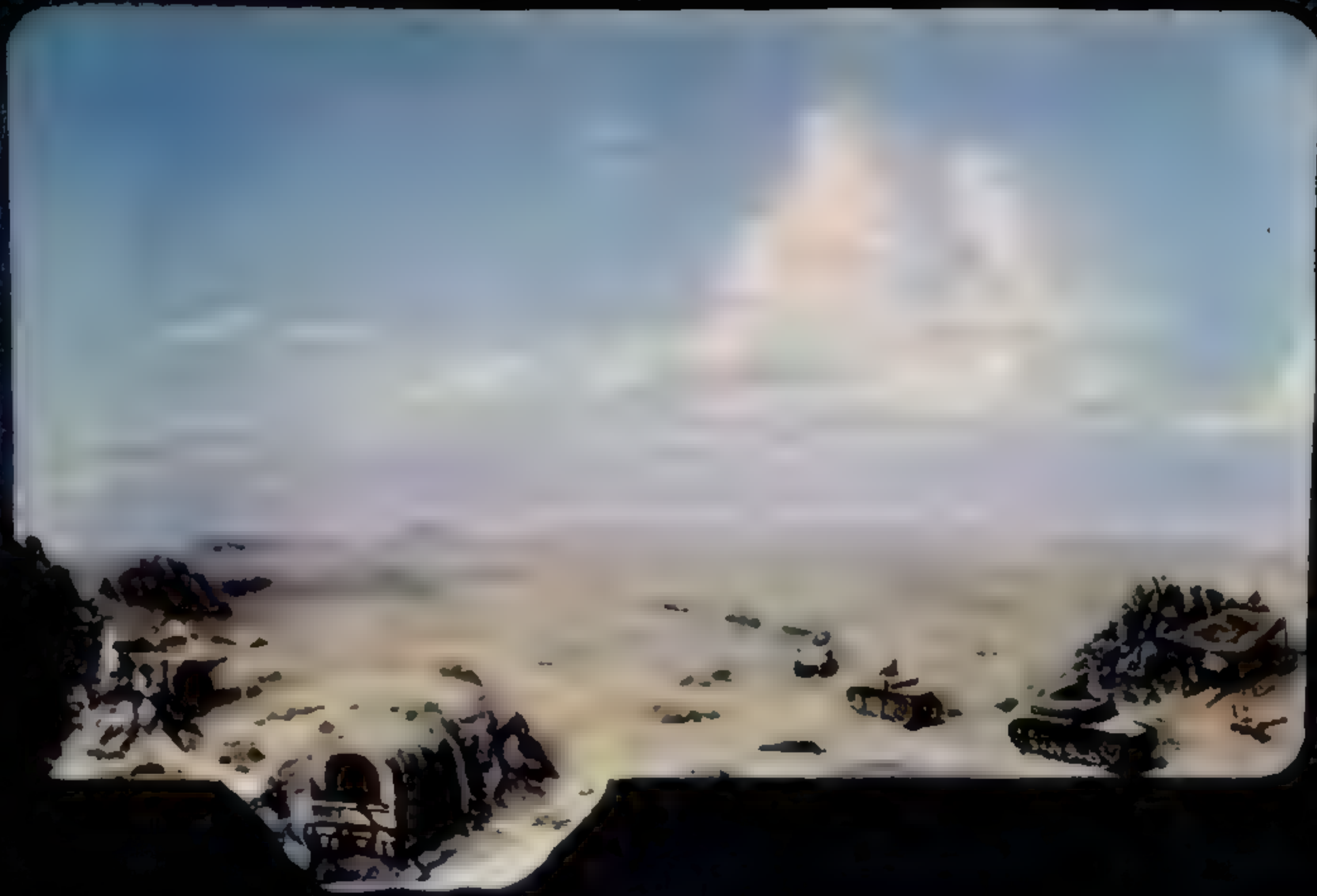
Some facts behind this achievement must remain a military secret. But one part that now can be told is the development of dioramas and training models as instruments of war. That project is a special task of the U. S. Army's Corps of Engineers. At engineer headquarters, you'll find miniature reproductions of coasts, deserts, and mountain ranges where our troops have already struck and where they're going to strike.

You'll find a beach scene in the Solomons so realistic that you almost expect to see Jap snipers dart from behind palm fronds. Next to it is a strip of cold, blue coast line in the Aleutians, with camouflaged anti-aircraft units shown going into action. Across the way is a hot, windy section of Africa, which vividly illustrates the scant camouflage possibilities and other challenging aspects of the desert. You get intimate glimpses of a dozen war fronts in five minutes without leaving that engineer workshop. These are the dioramas whose peacetime development reached its peak during the New York World's Fair three years ago.

Equally important in teaching camouflage and familiarizing officers and men with foreign terrain are the Army's training models. They differ from dioramas in that they depict terrain on a set scale, instead of tapering to give the illusion of distance. Models give you aerial views of beaches, hills, woods, bridges, lakes, and villages. They vary in size from one 20 by 40 inches, which can be packed in a carrying case, to a huge layout of an invasion coast that depicts miles of ocean frontage as it would

This Signal Corps photograph shows the amazing detail and realism of the dioramas which the Army uses to familiarize troops with terrain they are about to encounter. Can you tell where backdrop meets diorama's horizontal surfaces?

Made to show American troops the limited camouflaging prospects of the African desert, this diorama illustrates the use of burlap to cover trucks and wire netting to hide tanks and artillery. Kodachrome is by William W. Morris

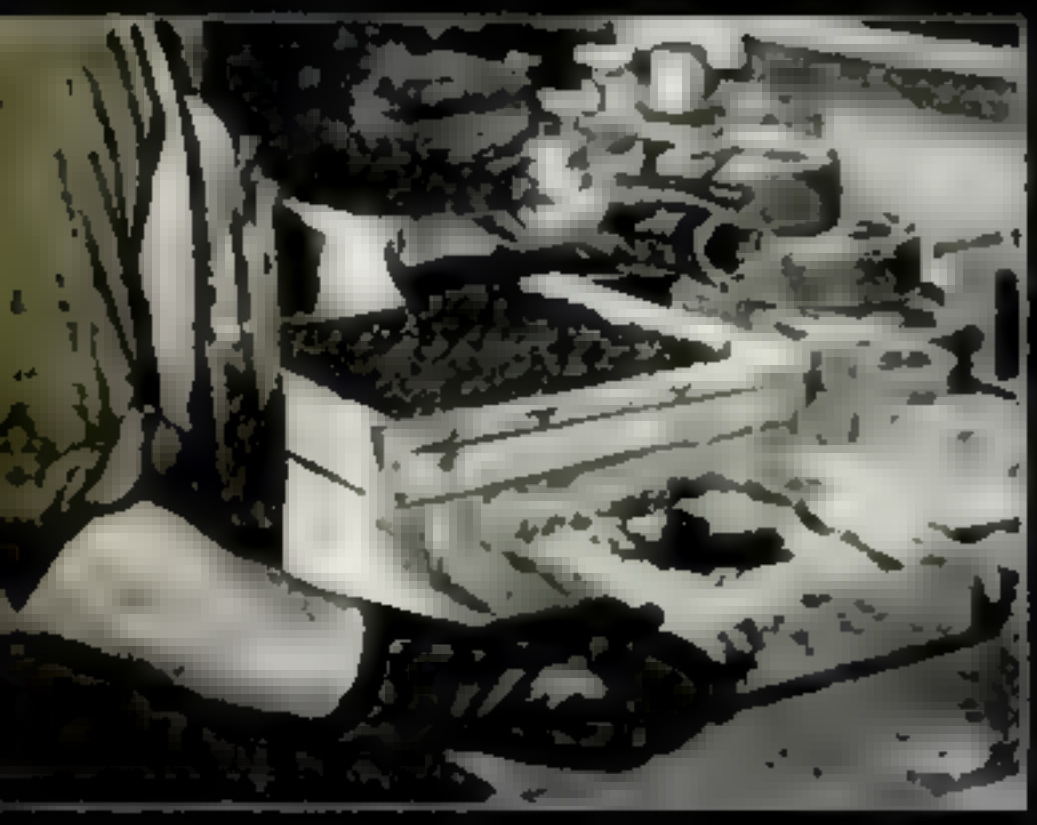


DIORAMAS

look to approaching troop convoys or fleets of troop-carrying planes.

The striking realism of these dioramas and training models results from the thoroughness with which the engineers and their civilian artists and craftsmen do their research. For into each miniature goes a vast amount of data from the war theater it will depict. Aerial photographs, scenic films, drawings, maps, writings, and reconnaissance reports are carefully studied. Findings are sorted, catalogued, and turned over to artists who produce a colored sketch. From that sketch—if it successfully passes the exacting standards set by the Army Engineers—eventually emerges the highly detailed miniature as a strategical military gem.

Foliage for the miniature trees is made from lichen moss, which, after being soaked in a water-alcohol-glycerine solution, is dried and painted



Here a skilled technician carefully stains sawdust which will form part of a new diorama. Wire, wax, glass, putty, and papier-mâché are also used

To produce a leafy effect on the larger trees, an artist sprays shellac on tiny bits of green paper scattered on a net placed around the lichen clumps

On a portable training model, an officer points out camouflaging possibilities. View appears as it would to a plane flying at several thousand feet

Field kits enable soldiers in combat areas to make on-the-spot dioramas. Fifty square miles of terrain can be duplicated on a six-by-six-foot model

His Models Died 40,000,000 Years Ago

Shown in relief is the skeleton of an early *Scarrittia*, found in an extinct Patagonian volcanic crater and used by the artist for the painting at the right. Scientific data indicates that the animals, wandering in search of water, discovered the lake in the crater. One of the animals is believed to have lain down to sleep and eventually to have been killed when the dying evening wind ceased to carry off the deadly fumes from the crater

Photos from "Natural History"

PICTORIALLY resurrecting prehistoric animals that have lain buried for as long as 40 million years is the interesting job of John C. Germann, staff artist of the American Museum of Natural History. After long and careful study of the skeleton parts which have been found by the fossil-diggers and then assembled into a lifelike pose, the artist must familiarize himself with the details of the country and climate in which the animal lived. From the completed skeleton he must then determine the musculature of the animal, and the type and coloring of its covering. The final job is to paint the subject in a characteristic pose.

1 Bones are often found incased in hard rock. To unearth them safely, the fossil-digger must use special tools. Erosion often helps him to make a valuable find

2 Once the bone has been uncovered, it is prepared for shipment by being splinted, wrapped with cloth dipped in wet plaster, and then crated

3 In the laboratory, a preparator removes the wrappings and proceeds to the delicate job of chipping away rock that still incases the bone

3 Not until he has made a number of sketches of the animal's skeleton, musculature, and covering, is the artist ready to paint the beast realistically in a carefully planned setting

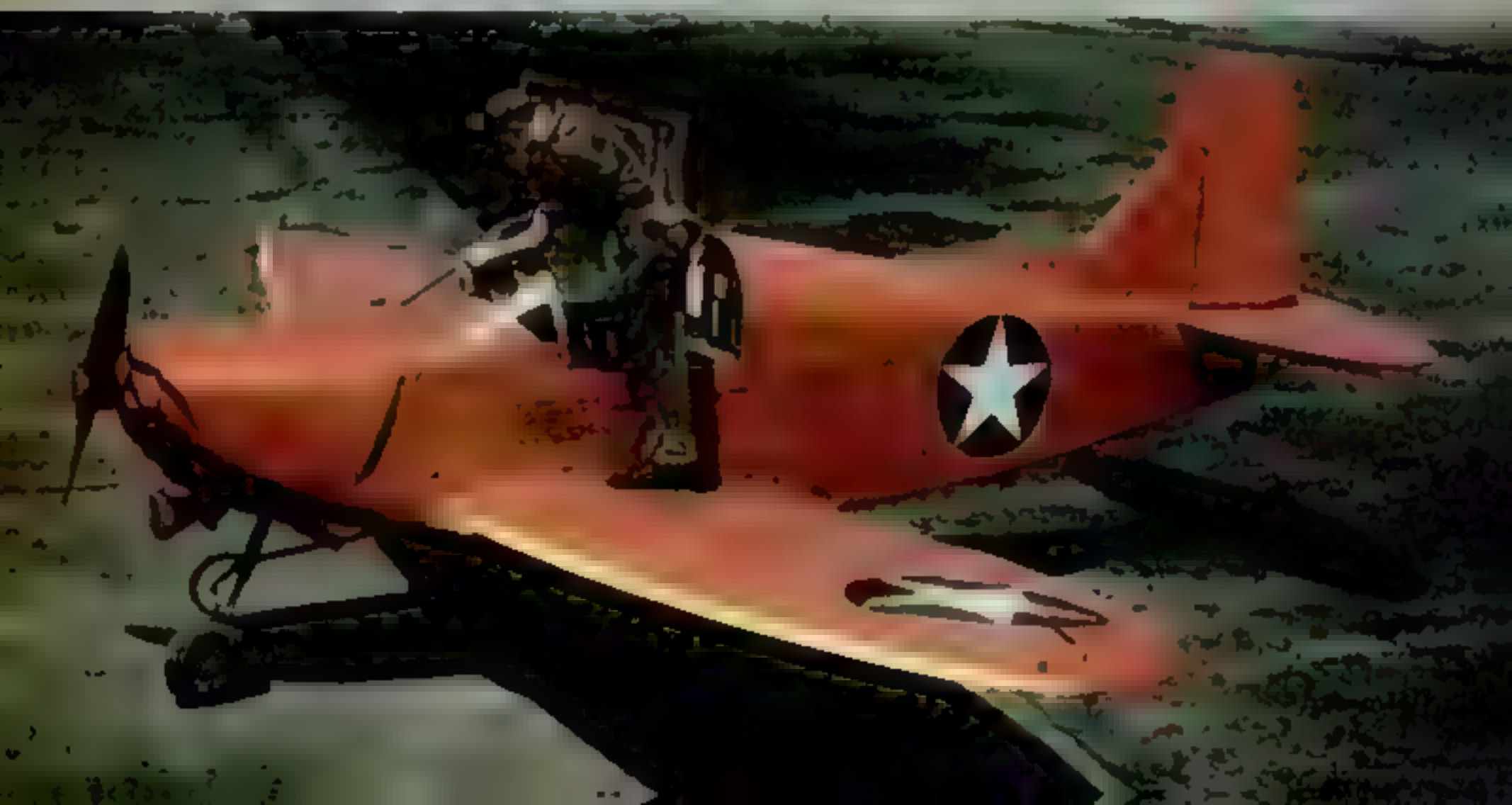
4 A specialist now studies the fossil to determine which of the bones it is, and just how it will fit in the complete skeleton

The Zebra and the Red Fox

STATIC TEST Here a fighter model designed by the Bell Aircraft Corporation, the makers of the famous Airacobra, is being put through a punishing weight test at Wright Field, Dayton, Ohio. Lines painted around the fuselage give a check on the strains and stresses produced in the various sections. Engineers are taking readings off wing

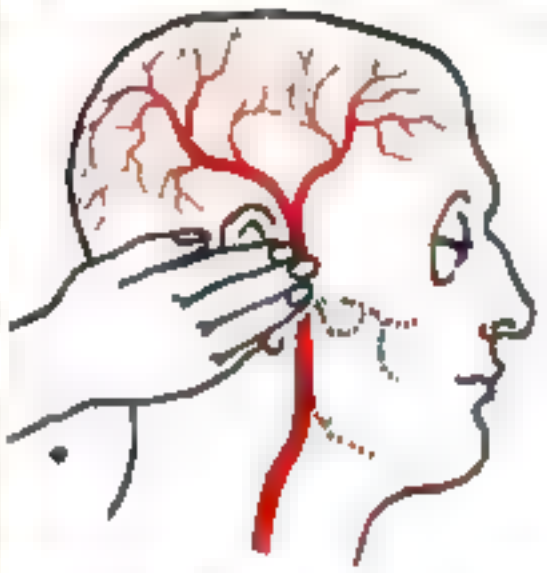
Kodachromes by Harold Kulick

CADET AT WAR. This tiny plane is an Army version of the Culver Cadet, being used in test work at Wright Field. The Cadet, a popular lightplane for sportsmen in peacetime, is here equipped with tricycle landing gear in place of the two-wheeled gear it employs when on pleasure bent

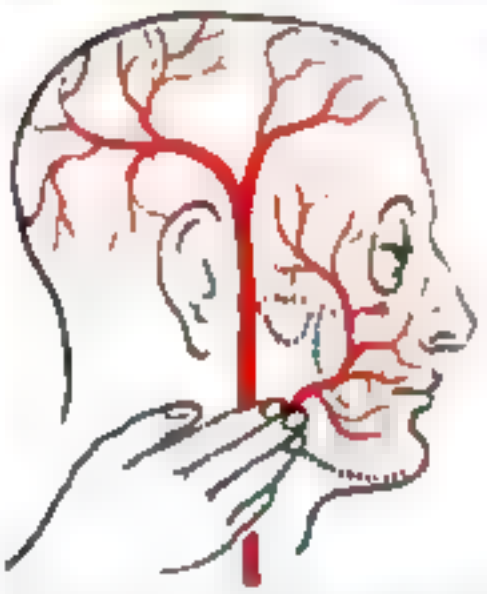


MANY an injured person has bled to death because those around him took time to improvise tourniquets or waited for a doctor to arrive. Such tragedies often can be averted by a knowledge of first-aid "pressure points," where application of the fingers will check the flow of blood through the arteries. The drawings on this page, based on material in "Air Force" magazine, show the locations of six arteries and the pressure points that control various areas.

Saving Lives with Your Fingers



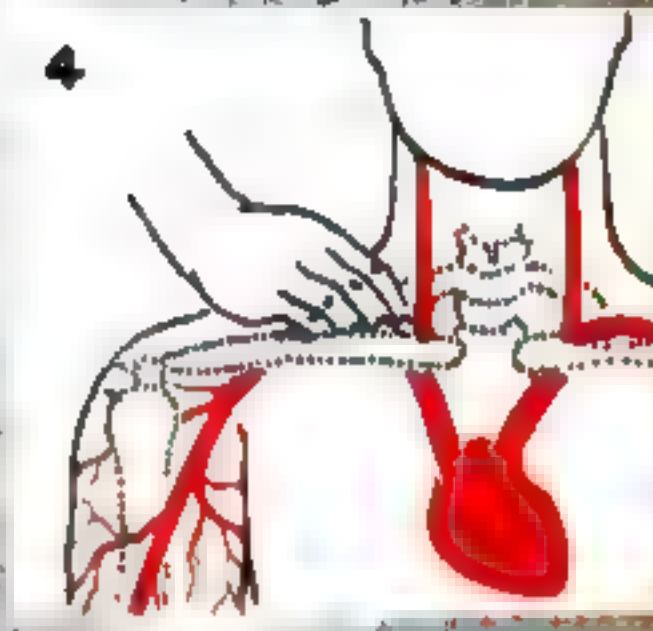
Pressing the temporal artery in front of the middle of the ear will reduce scalp bleeding



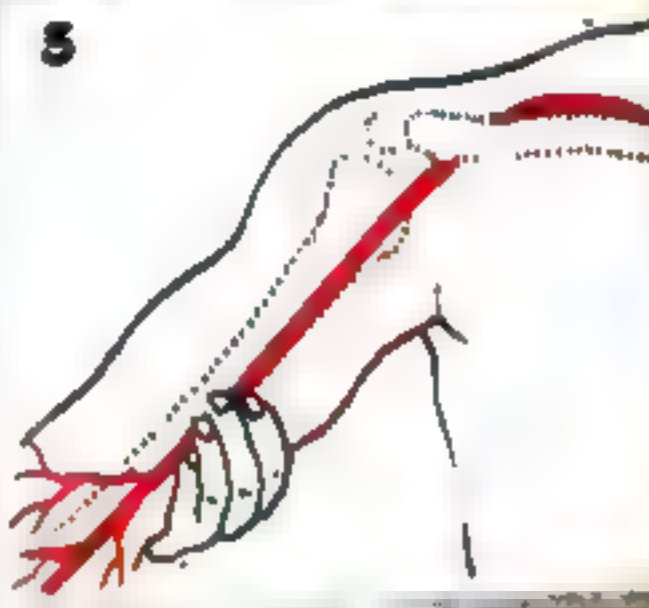
If the wound is in the cheek, press the artery in the notch on the under edge of the jaw

Pulling carotid artery in neck against spine stops bleeding above that point on that side

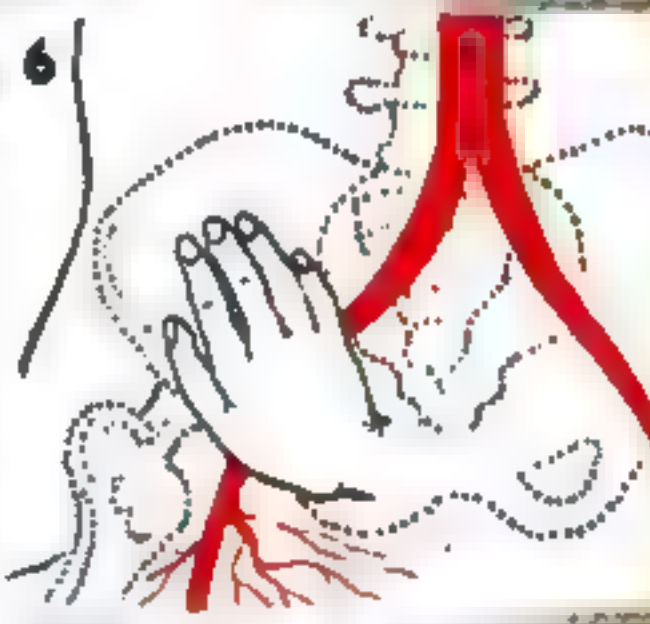
The temporal artery (1) can be located with the fingers by its pulsation. Only light pressure should be applied to this artery, as well as to the artery (2) under the jaw. In pressing the carotid artery (3), at least a moderate pressure should be exerted. To reduce arm bleeding materially, it is necessary to hold the subclavian artery (4) firmly to the collarbone. Strong pressure is also needed on the brachial (5) and femoral (6) arteries. In the former, wrist pulse should disappear



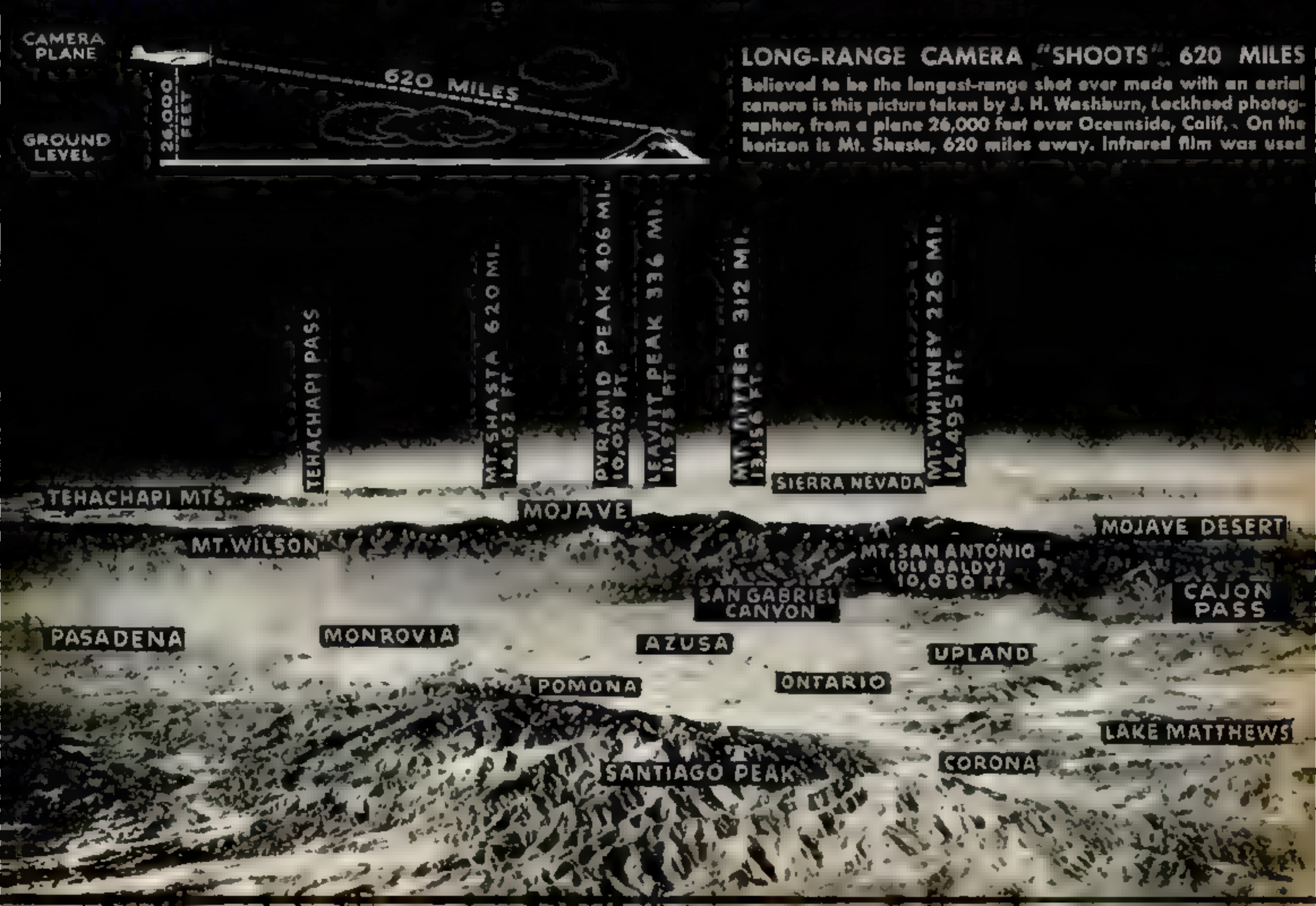
Behind collarbone is subclavian artery. Pressing it against collarbone stops arm bleeding



A hemorrhage in forearm can be controlled by pressing brachial artery against the bone



Holding femoral artery firmly against pelvis bone with heel of hand decreases leg bleeding

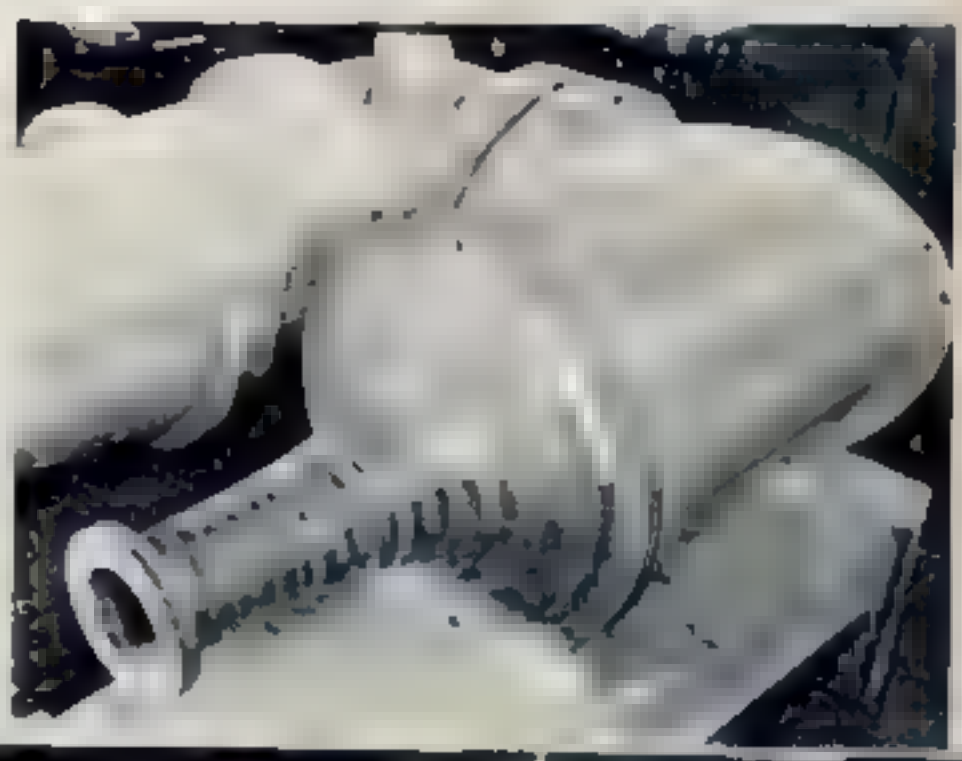


LONG-RANGE CAMERA "SHOOTS" 620 MILES

Believed to be the longest-range shot ever made with an aerial camera is this picture taken by J. H. Washburn, Lockheed photographer, from a plane 26,000 feet over Oceanside, Calif. On the horizon is Mt. Shasta, 620 miles away. Infrared film was used

BY PEERING into this transparent celestial sphere, student aviators see navigational stars and constellations on the opposite side just as they would actually look in the heavens. This is better than the usual sphere, which shows the stars as if seen from outside the universe. The sphere was designed by Lt. Col J. E. Davis of the Instrument and Navigation Branch, Wright Field, Dayton, Ohio.

A NEW WIND TUNNEL for testing plane models under conditions simulating the temperatures and pressures of altitudes up to 50,000 feet is being built by the Air Forces, Wright Field. Two giant fans will develop wind velocities of over 600 miles an hour, while a refrigerating unit will chill the winds to as low as 67 degrees below zero. A special device will enable the air pressure in the tunnel to be reduced to as little as one-eighth that of sea-level pressure.



The Avenger Scores Again

FLYING OFF THE ESCORT CARRIERS WITH DEPTH CHARGES, VERSATILE TBF'S CLEAR THE SEAS OF SUBS

By William S. Friedman

Kodachromes by Harold Kulick

SOMEWHERE in the middle of the Atlantic, a submarine's periscope breaks water. Scarcely have the first men scrambled out of the conning tower before a pursuit-speed, single-engined giant drops out of the clouds. The plane opens its capacious belly bomb bay; out tumble depth charges, and the erstwhile wolf of the sea becomes just another oil slick.

For the success of the Navy escort-carrier system that has vastly reduced the percentage of merchant-vessel sinkings much credit is due to the Navy's carrier-borne maid-of-all-work, the TBF Grumman Avenger

Designed as a torpedo plane, the Avenger was the first single-engined U. S. carrier type to carry internally a full 21-inch tin fish. It also serves as a light bomber, carrying the standard bombsight and bombs, and as an antisubmarine plane.

The Avenger was born when the cruising speed of the Douglas Dauntless fell short of modern combat standards. The new ship had to have enough cruising range to attack enemy capital craft inside the widest possible protective net, with weight to spare for defensive armament so that it would not require a fighter escort.

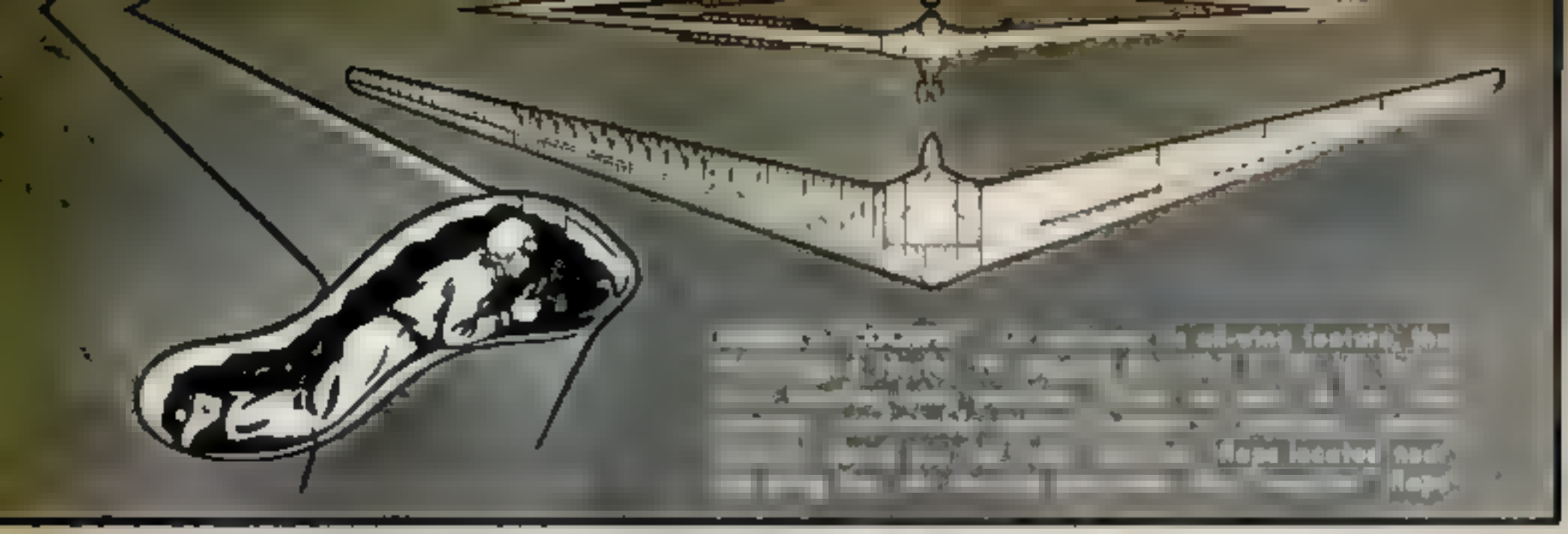
Grumman's answer was a midwing monoplane which many early Jap spotters mistook for the F4F Grumman Wildcat fighter. The new ship had a wing span of 54 feet 2 inches and was 40 feet long Powered by a 1,700-hp., 14-cylinder Wright Cyclone engine, it developed a top speed of 253 m.p.h., at sea level. Cruising varied between 120 and 200 m.p.h., depending on the mission. Carrying a normal load, it had a cruising range of over 900 miles.

The Avenger is a three-place airplane, carrying a pilot, observer-gunner, and radio operator. Probably the greatest single advantage of the plane is its amazingly low landing speed. The biggest ship on the carrier, it actually requires the same take-off run as the fighters, and even less deck space on which to land

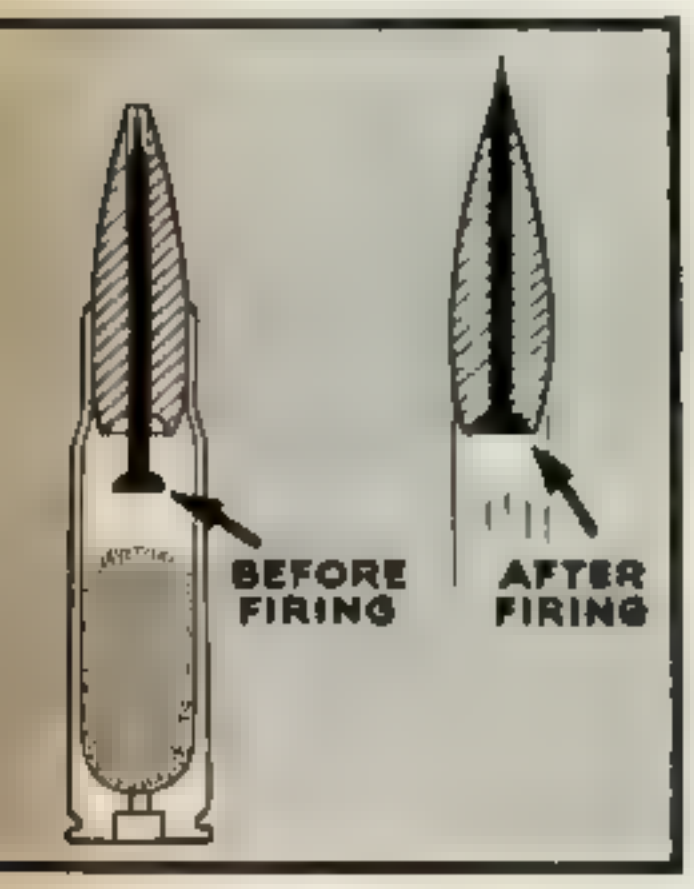
AS A BOMBER, the Avenger carries about a ton of "eggs" and uses the standard bombsight. For antisubmarine work, the bombs are replaced by depth charges. Wings are folded, as shown below, by hydraulic mechanism controlled by the pilot—a great advantage in operation from a crowded carrier deck

AS A TORPEDO PLANE the TBF hauls a full 21-inch tin fish. At the right, the 2,000-pound projectile is being hoisted off its dolly through the bomb-bay doors with a winch


35

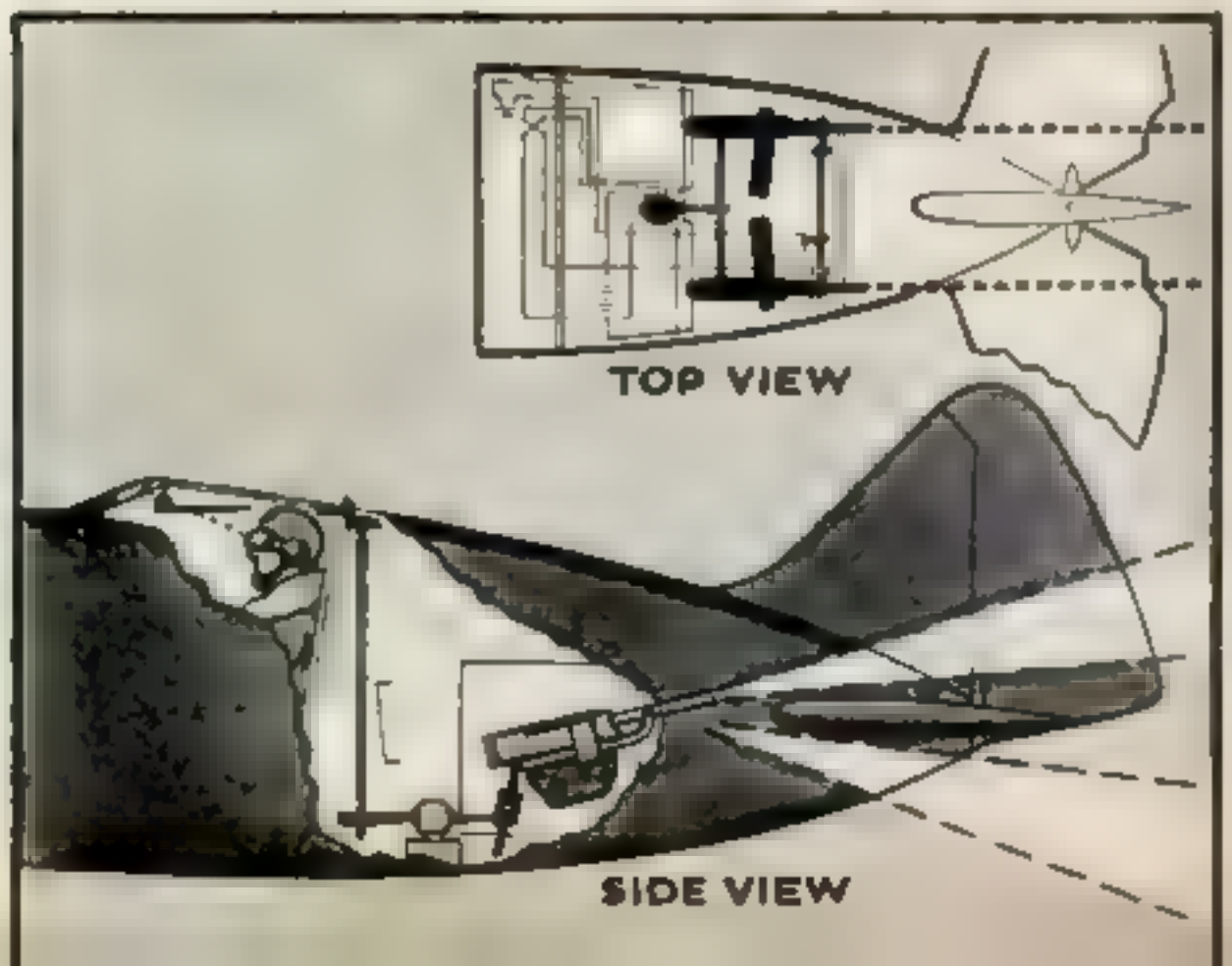


GLIDER. An all-wing, tailless, single-seater glider has been announced in the British magazine "Flight" as a recent achievement of the Horten brothers, German aircraft designers. Known as the Horten IV, the ship is reported to have stayed aloft for 9½ hours. Like all other tailless aircraft, the ship can be turned to the right or left only by banking. This is done by means of three individually operated flaps set in the trailing edge of each wing, which can be made to serve as elevators as well as ailerons. To add to the ship's maneuverability, two additional pairs of flaps, one in the leading edge of each wing, have been installed to serve mainly as "negative" elevators.



SHARP BULLETS are made possible by a shaft which the explosion forces forward so that its needle-sharp point extends beyond the bullet's nose. G. N Albree, of Winchester, Mass., is the designer.

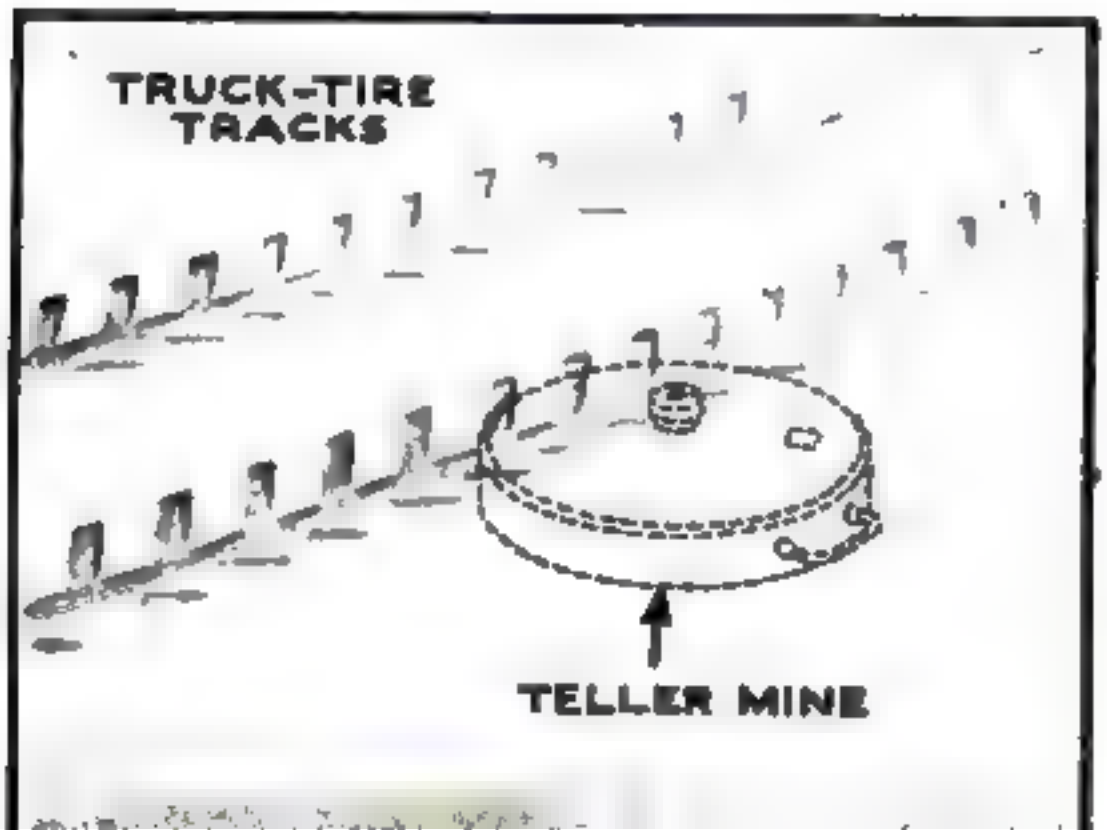
MIRROR-AIMED MACHINE GUNS, mounted at the rear of a single-seater fighter plane and pointing backward, have been suggested by John F. Haberline, of Seattle, Wash., as a means of enabling the pilot to blast any enemy plane that "gets on his tail" A mechanical arrangement permits the pilot to adjust the vertical angle of the guns while tracking the enemy plane in an overhead mirror.

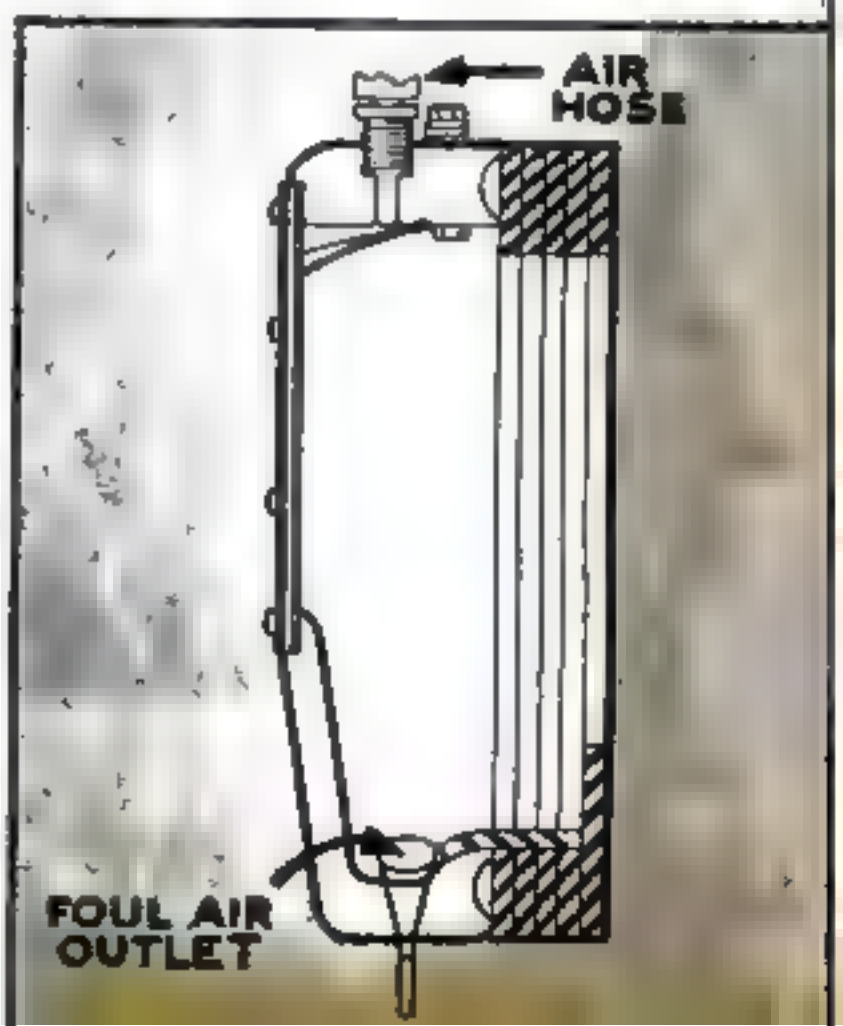


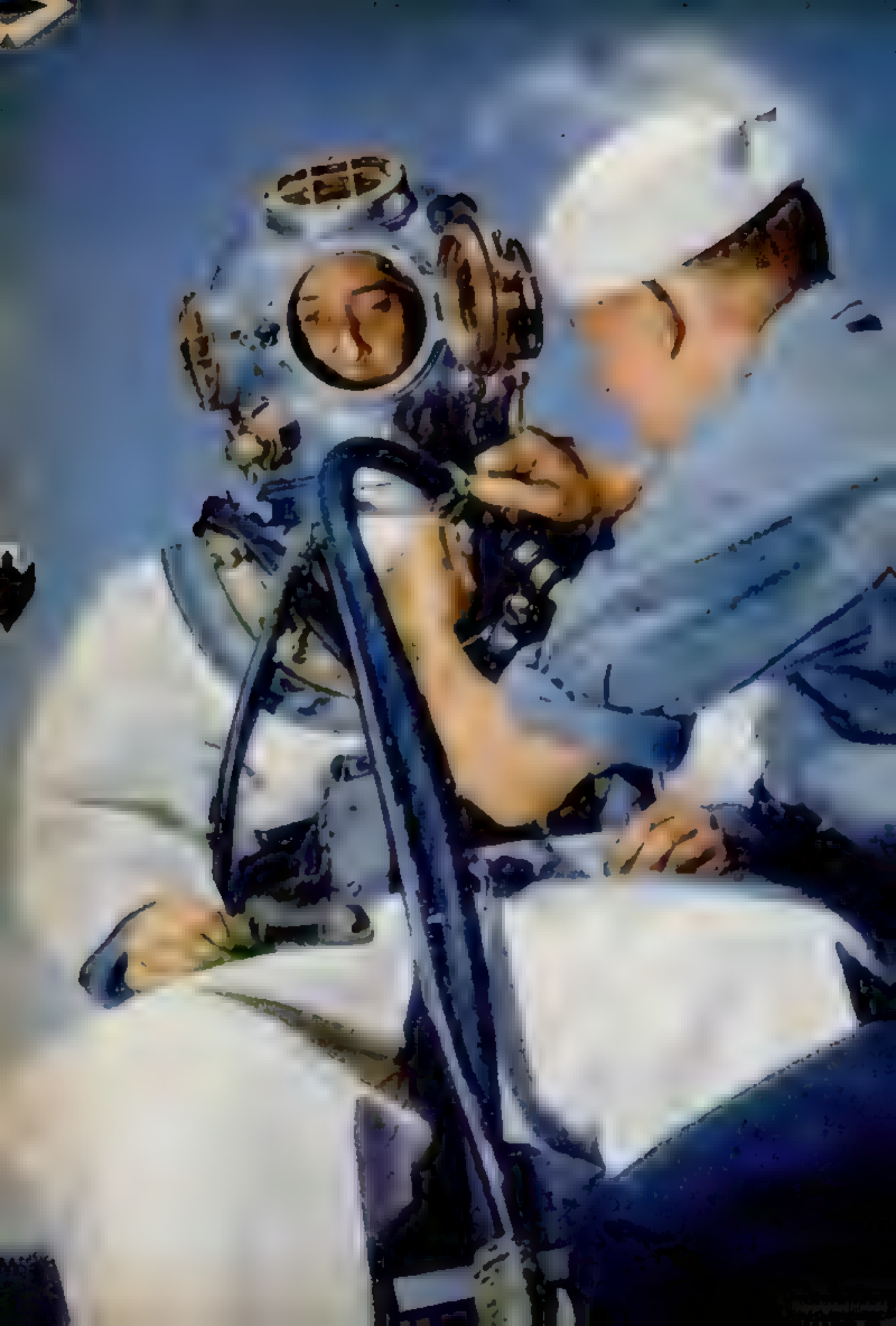
war ideas

SHALLOW-SEA DIVING, without the costly and cumbersome equipment usually needed for underwater work, can be done with this diving "faceplate" designed by Richard B. Comstock, U.S.N. Consisting of an oval frame fitted with a glass window and a sponge-rubber cushion around the edge to make a watertight contact, the plate is held on the wearer's head by means of straps. Fresh air enters through a hose connection at the top of the plate; exhaled air passes out through one-way valves at the bottom.

FAKED AMERICAN TIRE TRACKS came close, but not close enough, to luring American trucks into desert mine fields planted by German sappers. A Yank scouting car was prowling around one night with its headlights on when it came upon a German patrol laying mines. Seeing the headlights, the Nazis thought it was a friendly vehicle. They were promptly showered with hand grenades. Investigation then revealed that the Germans had run American tires over the sandy mined areas to give the impression that vehicles had safely passed that way.







They Bring 'Em Back Afloat

Our Navy can raise ships as well as sink them!

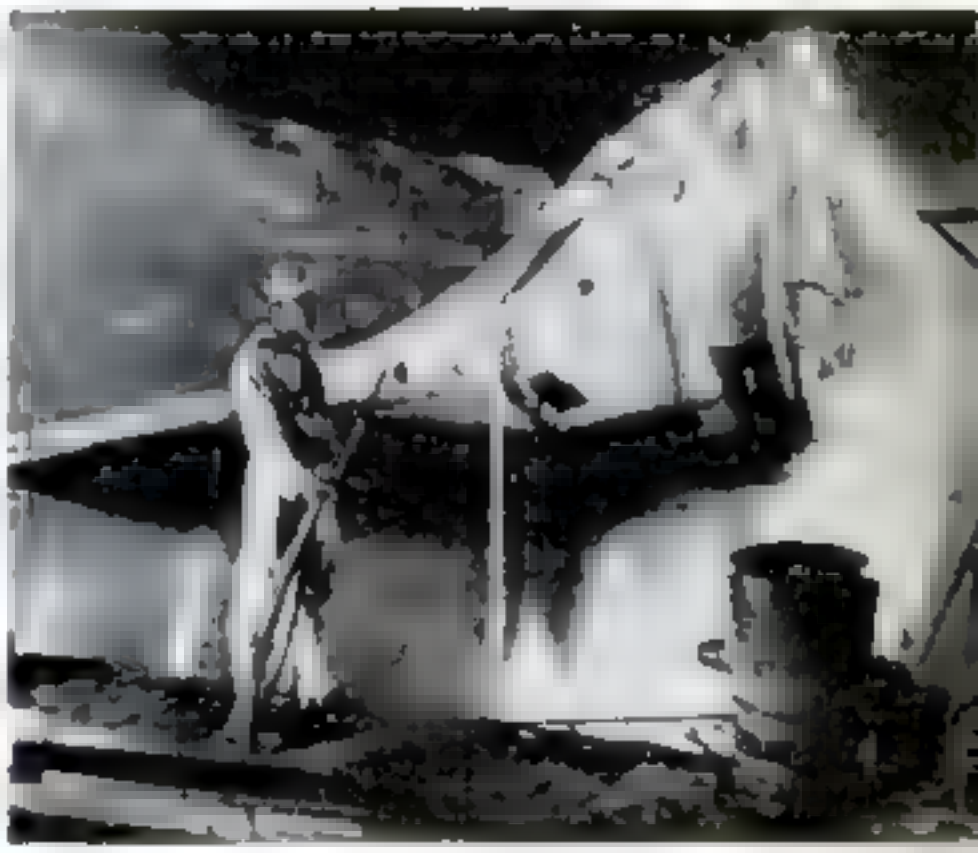
Mammoth salvage operations add priceless tonnage to the war and cargo fleets of the United Nations.

Drawings by STEWART ROUSE

FIVE million dollars represents the approximate cost of five Liberty ships, a single day's launchings. It also happens to be about all that Navy salvage in U. S. coastal waters has cost since the beginning of the war, not counting the *Normandie*.

But this second five million has paid a return, in the salvaged values of hulls, cargoes, and supplies rescued from the sea, estimated at over $400,000,000. We say "estimated" because the sum grows every day and because the Navy isn't saying too much about some of the phases of Navy salvage's world-

Continued on page 1

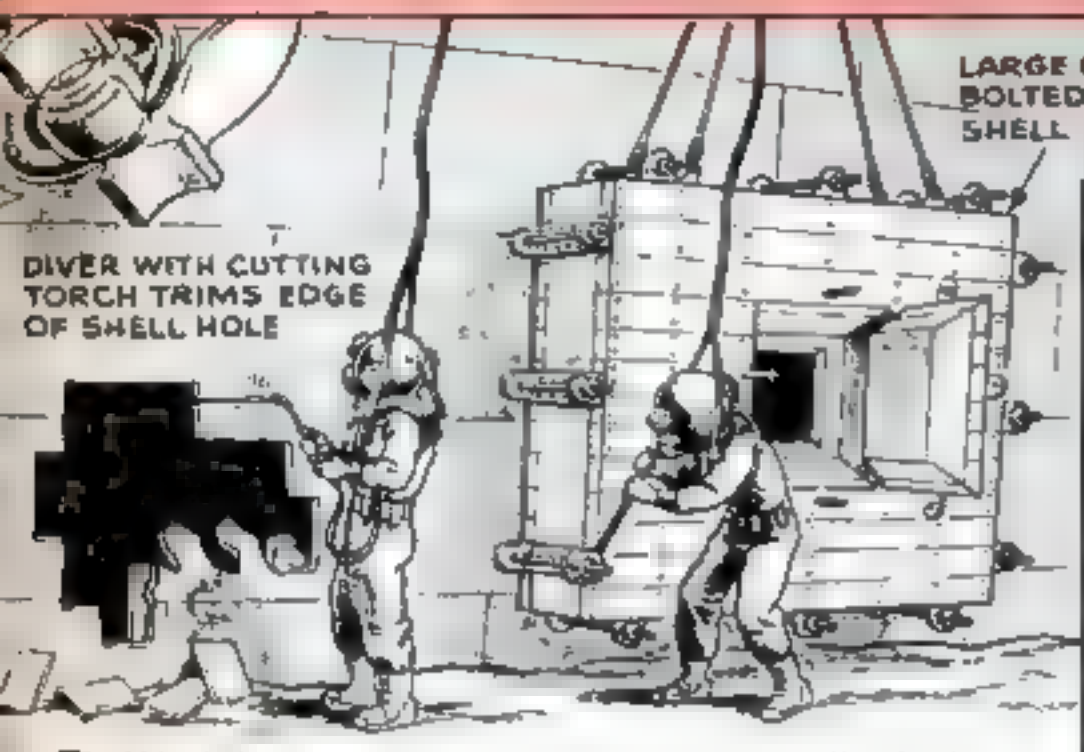


A student diver at the Navy's Salvage School in New York City gets ready to tackle an underwater training assignment. (Kodachrome by Robert F. Smith)

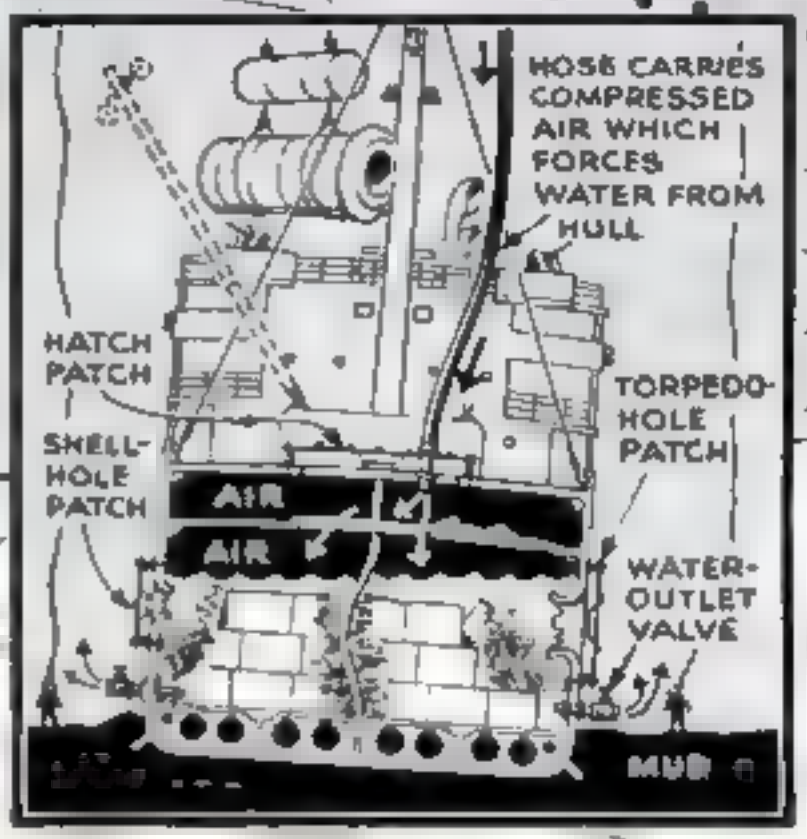
When the Normandie rolled over on her side (upper right), she gave Navy men the biggest ship-salvage job in history. Below, she is rising slowly as water is pumped out of her

THREE METHODS OF RAISING A SUNKEN SHIP

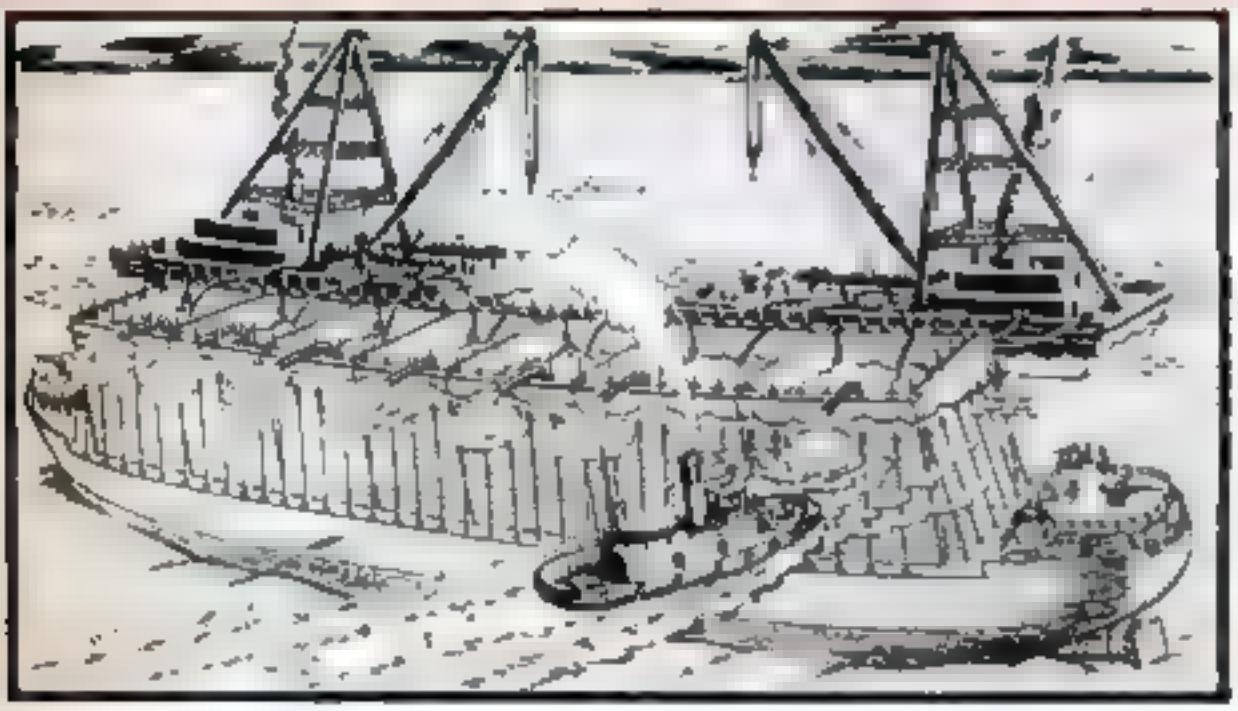
1. USING THE VESSEL'S OWN STRUCTURE FOR BUOYANCY



DIVERS put patches on holes in shell plating and seal up all companionways, ventilator trunks, and other openings in selected parts of the ship. Water is blown or pumped out of these compartments and the ship rises.



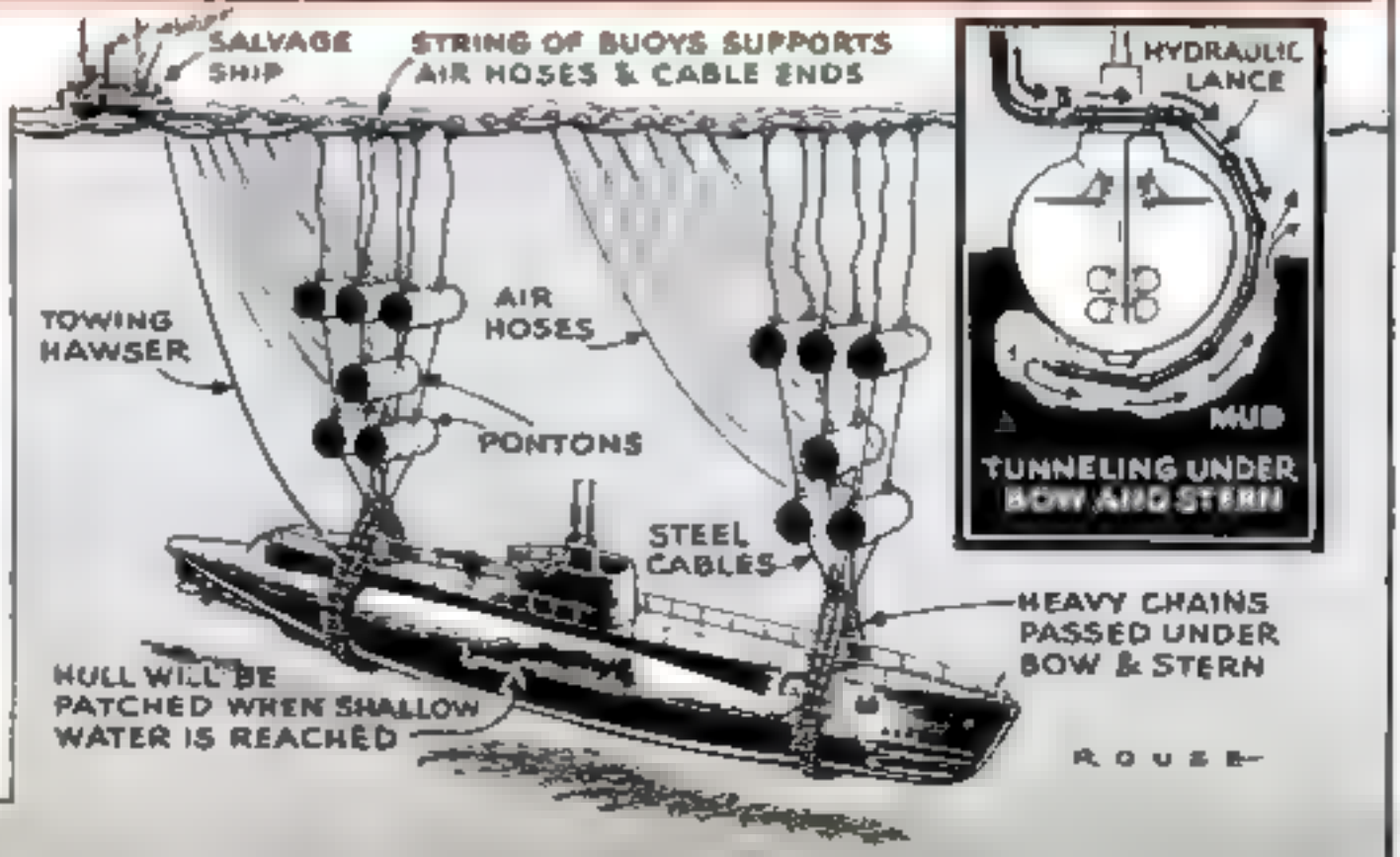
2. COFFERDAM METHOD (IN SHALLOW, SHELTERED WATERS)



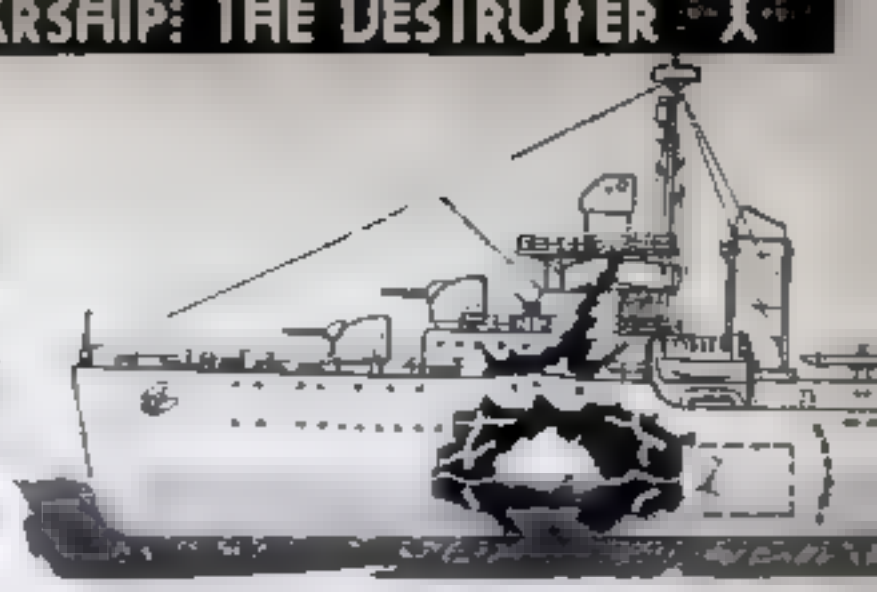
SUPERSTRUCTURE is cut away and smaller holes are sealed. Weak decks and partitions are shored. Then a watertight cofferdam is constructed in sections and floated into position, where it is fastened tightly to the vessel with cables and turnbuckles. Since the top of the cofferdam extends above the surface of the water, it and the hull can be pumped dry as a unit. Thus lightened and made buoyant, the hull then rises and floats.

3. PONTONS (ESPECIALLY EFFECTIVE WITH SUBMARINES)

IN DEEP waters, where the methods shown above are not practical, salvage engineers use pontons. Tunnels are cut under the hull by hydraulic pressure and chains are passed under. Pontons attached to the chains lift the vessel to the surface when the water is blown out of them. This method is impractical with large ships.

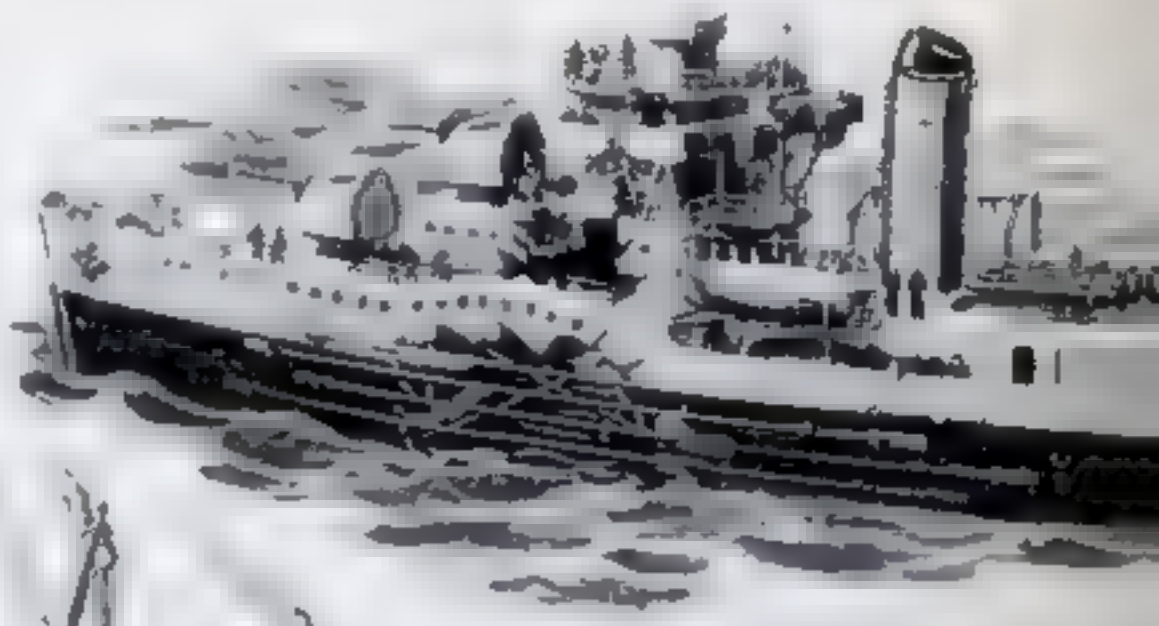


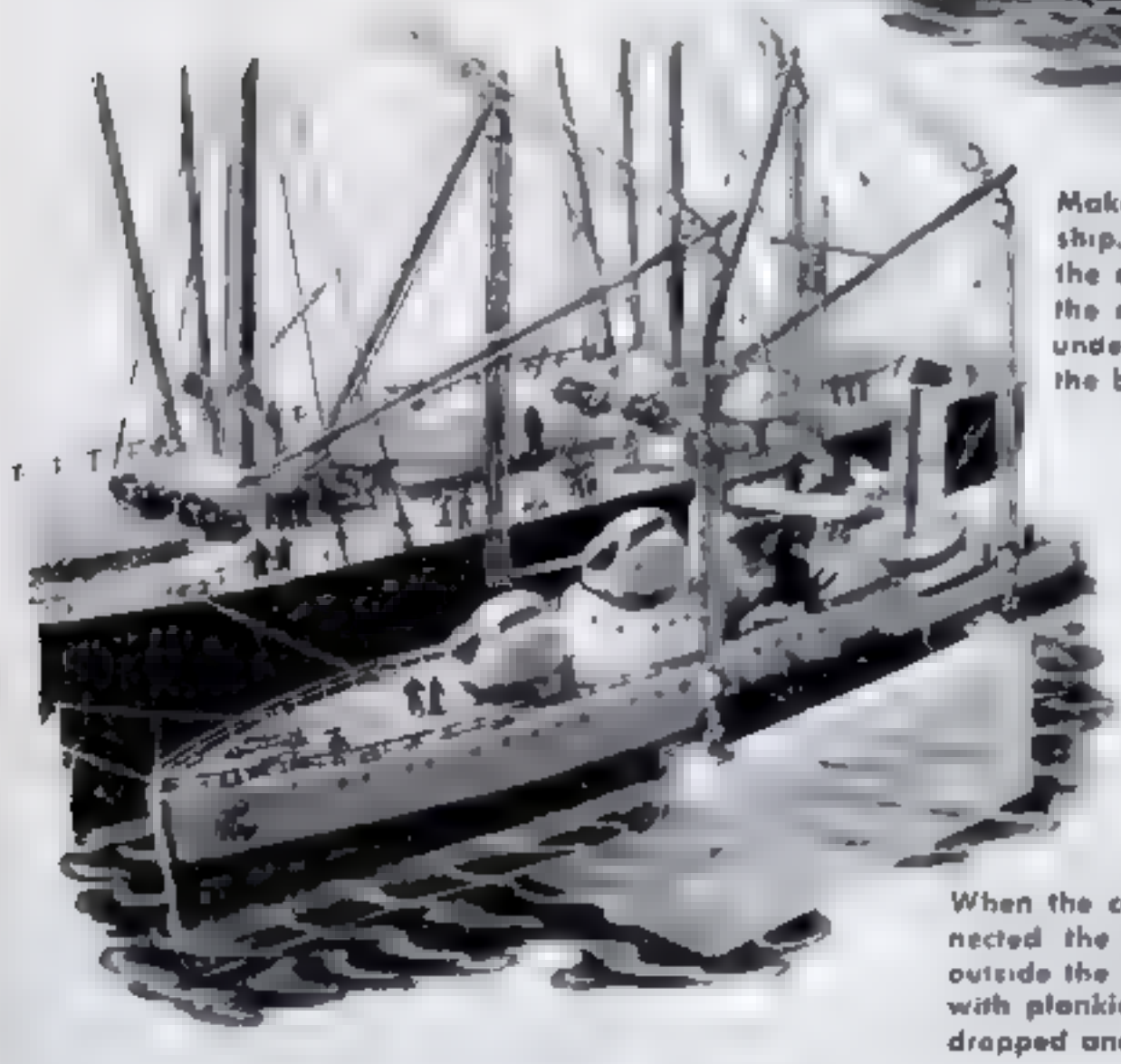
SAVING A WARSHIP: THE DESTROYER "X"



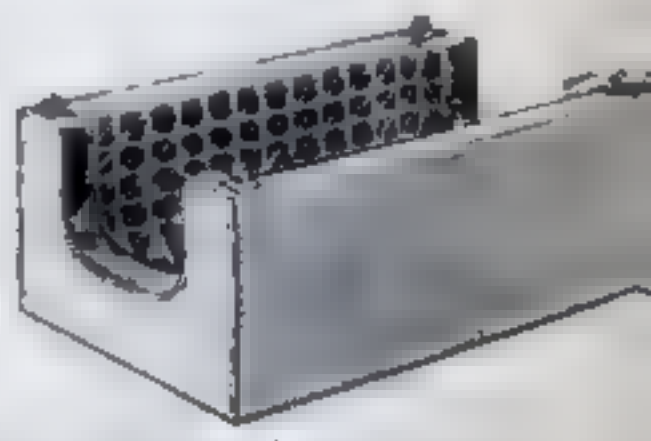
In a cold dawn on the North Atlantic Destroyer "X" was scouting ahead of her convoy when a German torpedo struck her below the bridge The explosion left the vessel almost torn in two with part-side plating blown away, a big hole in the starboard side, and decking torn out Bridge and deck-house were damaged Only the plating left on the starboard side held her together

Her own crew literally "tied her up with string," running cables fore and aft and tightening them with turnbuckles. Damage-control parties shored up the bulkhead between the forward boiler room and the forward engine room, which was crumpled but intact

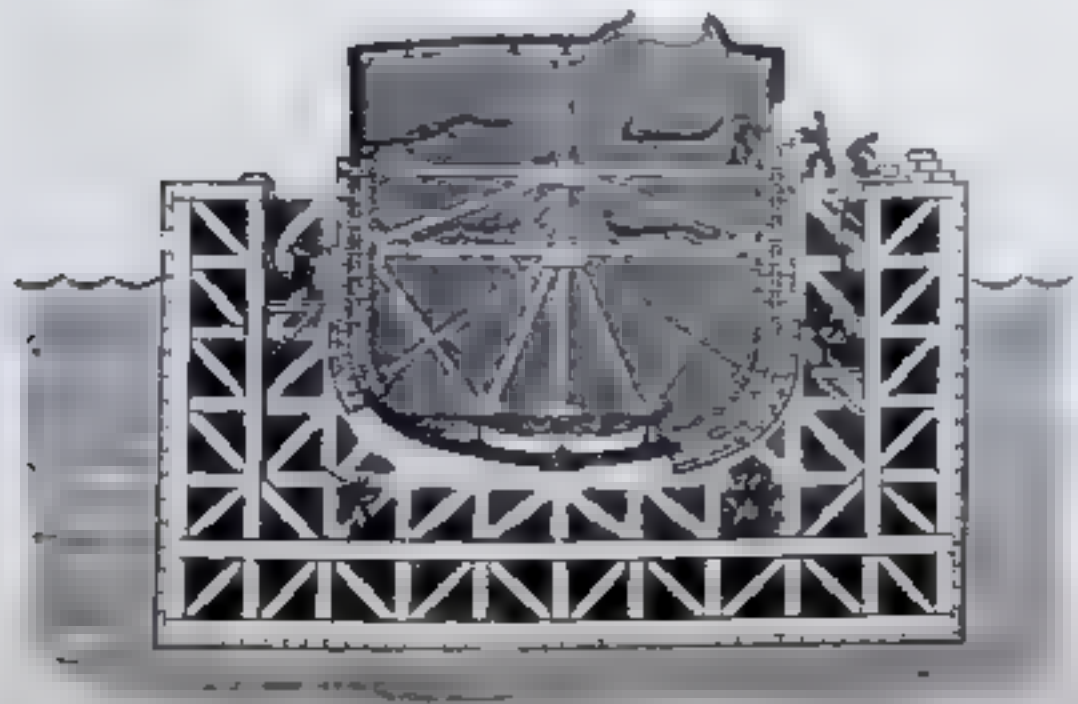


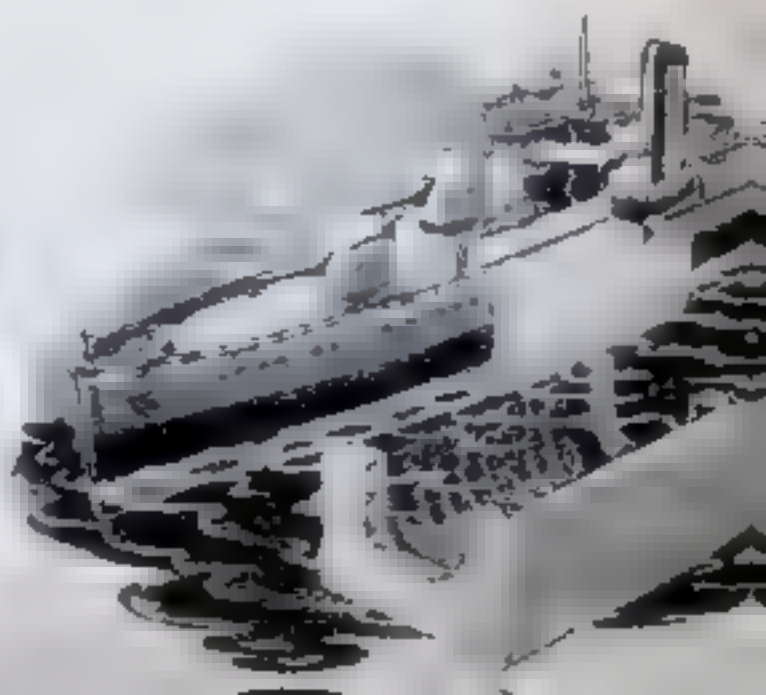


Making port, she tied up alongside a repair ship. A horseshoe-shaped caisson, sized to fit the damaged area, was built on the deck of the repair ship. Derricks lowered the caisson under the destroyer's bow and worked it aft to the break, where it was made fast to the hull



When the caisson was pumped dry, carpenters connected the two sections with timbers inside and outside the hull, bolted together. These were covered with planking and canvas. Finally, the caisson was dropped and the vessel was ready for the trip home





wide activities, the greatest and most far-flung salvage work of all time.

Since 1941, when Congress passed a law permitting the Navy to salvage both publicly and privately owned ships, we have heard a lot about some phases of this work: the raising of the *Normandie* and the refloating of the battleships in Pearl Harbor. But most of the work has been done quietly, either to prevent enemy interference and bombing of work in the war zones, or because there was no need to inform Hitler and Hirohito that ships they thought safely sunk are again carrying cargoes for the United Nations.

The Navy salvage chiefs, whether they work in Eritrea or in the Solomons, in the fog-bound Aleutians or en route to Murmansk, must always work pretty much on their own. Every salvage job calls for quick, flexible planning and ingenuity in devising salvage methods.

All salvage jobs, however, fall into a few general classes. The trick is to adapt the standard salvage methods to fit each new task.

One of the largest classes, in terms of tonnage saved, is that of ships which are disabled but not sunk. Here salvage in the Navy begins the moment a ship is hit, when repair parties explore the damage and try to limit it. They shore up weak bulkheads, patch small holes, pump out compartments, and restore or improvise hose and communications lines, so that the ship can, if possible, get under way again

When the injuries are so great as to prevent the ship making way under its own power, towing is resorted to a tricky and dangerous job in heavy and icy seas with enemy

NAVY TRAINS DIVERS ON THE SPOT

To train divers for the exacting work of ship salvage, the Navy set up a unique school at Pier 88 on the Hudson River, in New York City, where the Normandie lay. Navy men who apply for this work are given classroom instruction, and then go down from the float shown below for practice in using cutting torches, applying patches, and other tasks encountered in salvage operations

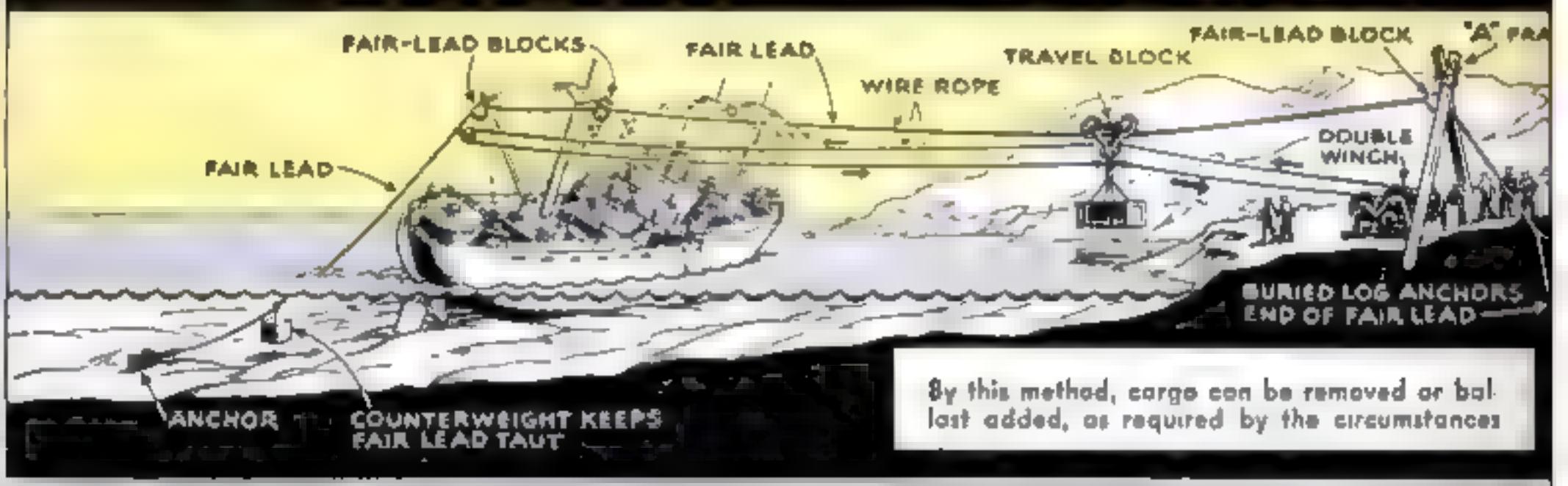
subs always presenting an added element of danger for both the injured ship and the rescue vessel. Once towed into harbor, a disabled ship can usually be repaired and a very high percentage of its value recovered.

Stranded ships fall into an in-between class. In wartime, these are often ships that have been deliberately run aground to prevent their sinking. Hence they may have great holes in their hulls, which must be repaired or temporarily patched in an angry surf before the ships can be refloated. In such cases, the most obvious things are usually the worst things to do. The amateur would think that discharging ballast and cargo would lighten a ship and permit her to float off. But usually, when this has been done, rough seas have heaved the ship farther ashore and either completed the wreck or made salvage far more difficult.

The skilled salvage man, therefore, first tries to make his ship stay put. He *adds* ballast. Then he runs out beach gear, setting anchors a few hundred feet from the ship. Usually he plays safe and sets these to all four quarters, until he can get a chance to study the lay of the bars or reefs and decide which is the best direction in which to haul off.

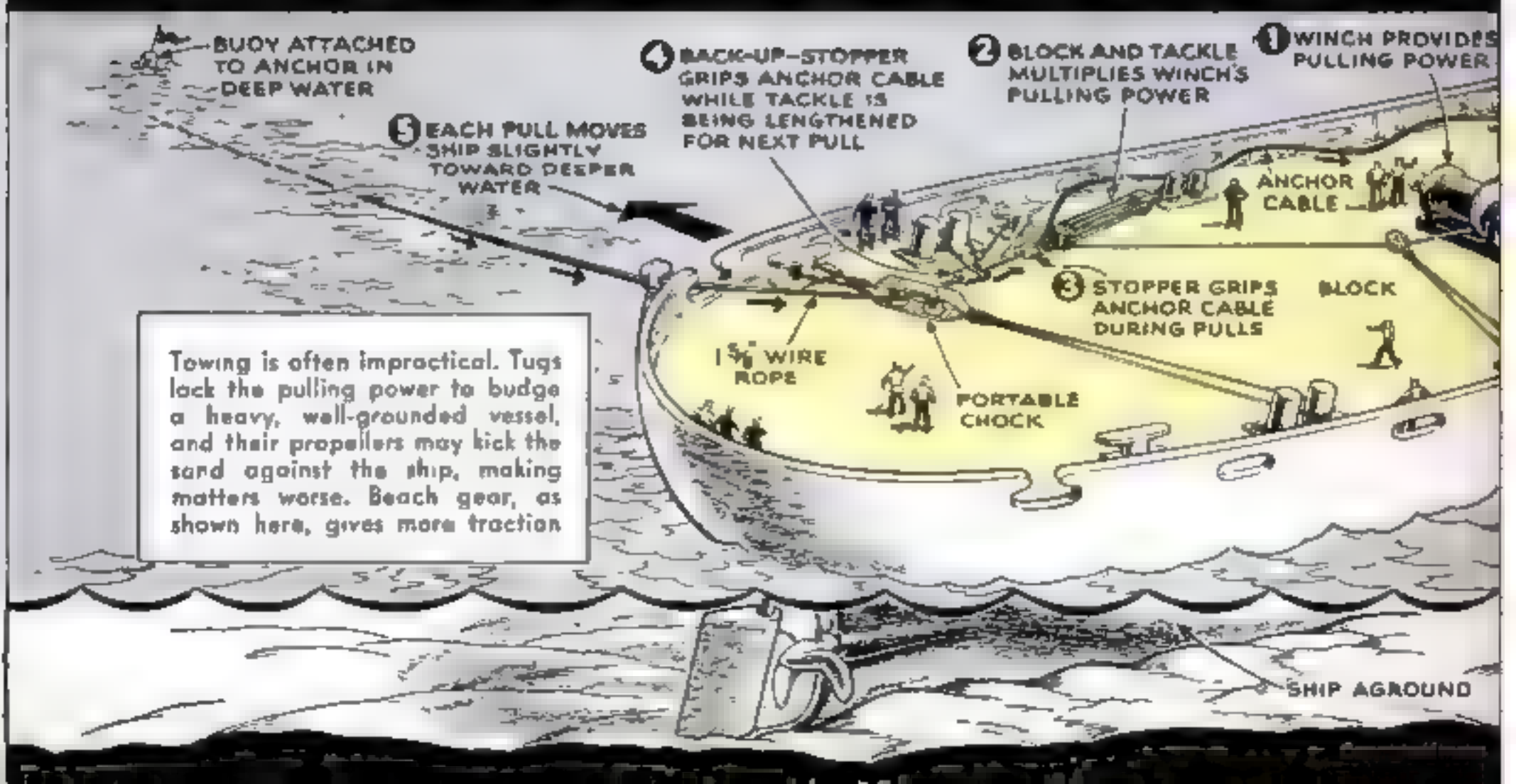
Another bright thought of the amateur is towing. If a ship is very, very lightly aground, towing might help in a rising tide and a calm sea. But whenever conditions are bad—and they usually are—towing may make things worse instead of better. A 10,000-ton vessel may be resting 1,000 tons of its weight on the ground. Three hundred to 500 tons' pull will be required to overcome friction in pulling 1,000 tons along the bottom. And the biggest tugs seldom have a pulling power of over 15 tons, because they must gain all their power through the pull of their propellers in the water. What usually happens is that the tug stays put on the end of its cable and its propellers churn up the sandy bottom and send it against the hull of the ship, making the task harder. With beach gear and anchors,

HIGH-LINE LIGHTENS STRANDED SHIP OR ADDS BALLAST



By this method, cargo can be removed or ballast added, as required by the circumstances

BEACH GEAR MOVES VESSEL TO AID SALVAGE OPERATIONS



Towing is often impractical. Tugs lack the pulling power to budge a heavy, well-grounded vessel, and their propellers may kick the sand against the ship, making matters worse. Beach gear, as shown here, gives more traction

a much greater pull can be exerted.

Tugs can be useful, though, in refloating a stranded ship. One way they are used is to scour the silt and sand away from the ship's hull, by the action of their propellers. Sometimes they tie themselves by the bow to the stranded ship and thus dredge a channel through which the ship can be hauled into deep water. High-pressure hose lines are often used to remove silt or to form working channels alongside of stranded or sunken hulls, when patches are to be applied to the sides or bottoms.

By far the most spectacular sort of salvage work, however, is that in which sunken ships are raised. One method utilizes the ship's own structure to attain buoyancy. Divers go down and explore the hull, locating all holes and measuring them. Then the engineers decide which holes must be plugged up or sealed to make pumping or blowing possible. Since modern ships are divided into compartments, it is not necessary to seal all openings under water. Many can be left to later work after flotation and docking.

The choice of pumping or blowing depends on circumstances. Pumping is accomplished with ordinary large-capacity gas-driven pumps or with electric underwater pumps. Blowing involves the use of great air compressors on the salvage vessel, which force air down through hose lines and thus blow the water out of chosen compartments. When a sufficient number of compartments have been blown free of water to restore buoyancy to the vessel, it rises to the surface

For ships in relatively shallow water and in protected bays and harbors, the cofferdam method offers some advantages. This method involves building up a ship until it stands clear of the water at high tide. If this can be accomplished, the water can be pumped out of the combined structure—hull and cofferdam—very much as if a giant bailing operation were being carried on.

The cofferdam itself may be built around the whole hull or around selected deck openings, such as cargo hatches. The structure is usually built in sections ashore and floated or carried on barges to the wreck. Floating derricks aid in setting it in place, while divers secure each section to its corresponding portion of the ship, using cables and stays and turnbuckles until they achieve a watertight joint.

While both the cofferdam and seal-and-pump methods involve the restoration of buoyancy to the ship itself, this cannot always be accomplished economically Ships sinking in deep waters—submarines, for example—are often too difficult to work on for the long periods these methods require. Therefore, salvagers fall back upon a modernized version of one of the earliest salvage methods. This involves the use of large cylindrical pontons—great tanks that can be submerged alongside of the wreck. Once attached, they are pumped or blown clear and thus float the wreck to the surface in a single stage. The method is ideal for the raising and relocation of relatively small wrecks lying at substantial depths.

Curiously enough, some of the jobs that look the hardest are actually easier than some others. A floating dry dock, for instance, seems to present the most difficult of all salvage jobs, especially if it has been effectively scuttled. However, a dry dock is a vessel originally constructed for great buoyancy. It must float both itself and another vessel. Thus, to raise the dry dock alone requires the sealing off of only a few of its many compartments.

The decks and bulkheads of a floating dry dock also are built to much higher standards of strength than are those of most ships, for the decks must support the weight of great ships, and the bulkheads must withstand water pressures in the process of submersion and flotation, which is the dry dock's way of working. Hence, salvage of such a vessel may actually prove easier than the lifting of a much smaller hull.

By no means all sunken or derelict ships can be salvaged, even in peacetime. Four hundred feet is almost the maximum depth at which any work at all can be carried on; most salvage work is done at much shallower depths. Many ships that sink even in shallow waters are simply blasted away as dangers to navigation, since their value "as they lie" does not sufficiently exceed the cost and risk of the salvage operation they would require.

Despite these limitations, Navy Salvage does not lack for work. Before the war is over, it will have restored well over a billion dollars' worth of ships and cargo to the United Nations, and that figure is based upon *value after salvage*. The true worth of Navy Salvage cannot, of course, be estimated, for it must include the immeasurable value of having cargo vessels and combat ships *now*, which could not be built new in our capacity-taxed shipyards. In that sense, the hulls that rose out of the mud at Pearl Harbor, and countless others, are "finds," ghost ships rebuilt to better-than-before fighting power, now hitting back at the enemy that treacherously sent them to the bottom.—ALBERT Q. MAISEL.

American bombers, swarming in from the sea, are depicted dropping block-busters into the craters of Japan's volcanoes to set them into fiery eruption

Can We Blast Japan from Below?

An eminent geologist suggests that bombing volcanoes might let loose a wave of destruction and terror among the enemy.

By HAROLD O. WHITNALL, D.Sc.

Professor of Geology and Geography, Colgate University

Drawings by B. G. SEIELSTAD

JAPAN sits astride the most unstable piece of crust on the earth's surface. It has 30 active volcanoes, to say nothing of hundreds that jut skyward in uneasy slumber. Earthquakes are as numerous as shooting stars in August. Hardly a day passes without some of Hirohito's dupes feeling the earth wobble beneath their feet. Fear of volcanoes is so thoroughly ingrained in the minds of the Japanese that they have made gods of them, placing shrines at the bases to appease threatened anger with gifts and supplications. So great is their awe of

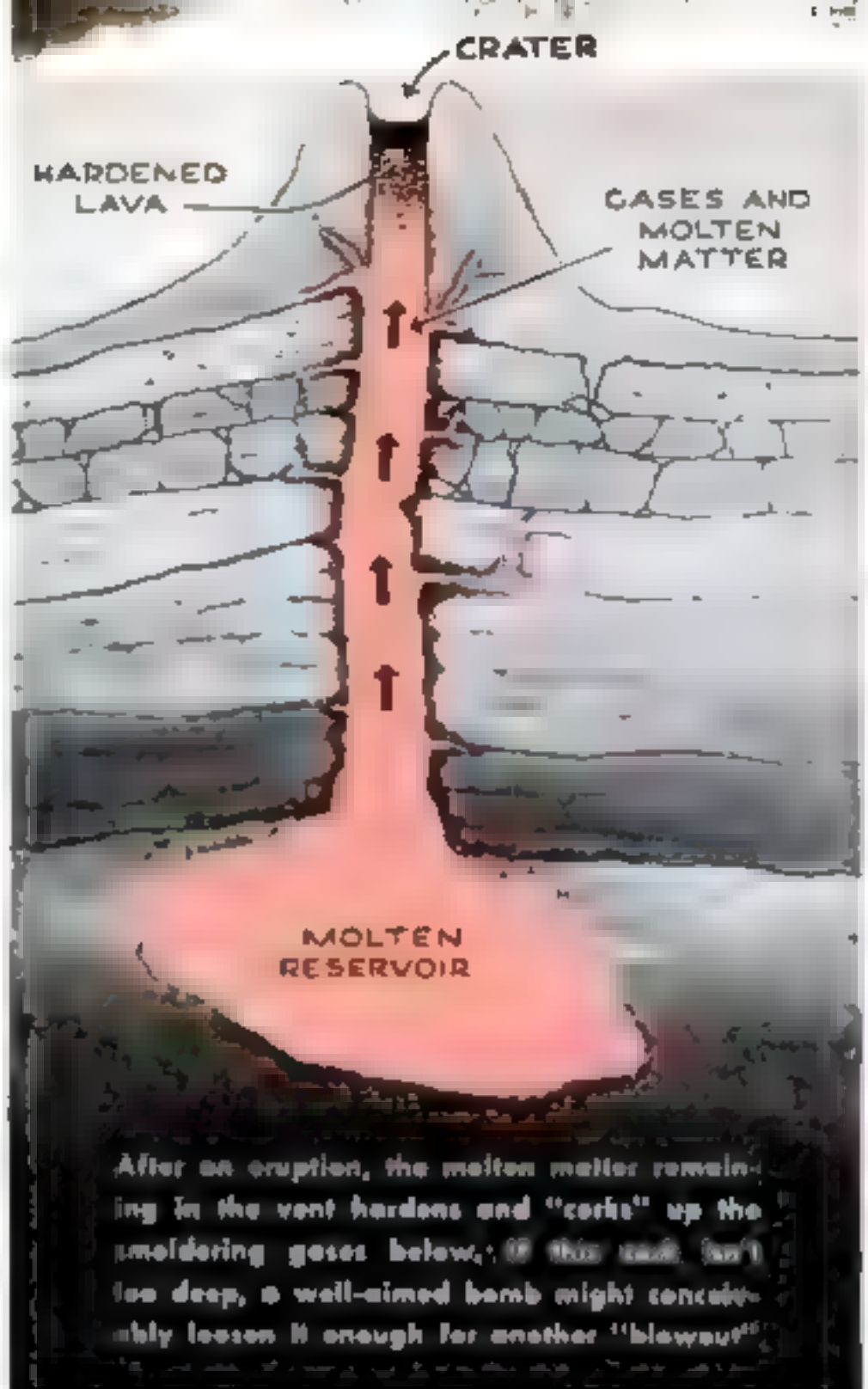
these smoking mountain deities that it is reasonable to believe that bombing attacks on them would loose the same cataclysmic terror that undoubtedly would ensue if our bombers blasted the palace of the Emperor —the so-called descendant of the Sun-god.

But block-busters might do even more than that. Since shortly after Pearl Harbor, I have recommended that our all-out attack on the Japanese homeland be accompanied by bombing raids on Japan's volcanoes. I believe that explosives dropped down their throats may cause such a vomiting of lava and ash as to hasten the day of unconditional surrender. Bombs are growing bigger and bigger, and I am increasingly convinced that such an attack is worth trying.

Rising abruptly from a deep part of the Pacific, Nippon's island empire is largely volcanic. Adding to this precarious condition is a series of long and deep fractures or faults in the earth's crust that run along its eastern coast. Similar lines cross the islands from east to west. These lines of weakness are like an inverted sword of Damocles which threatens from below instead of from above. They permit great blocks of the earth's crust to slip against one another. Each time such a displacement occurs, an earth tremor results. The possibility of widespread volcanic activity as well as severe displacements puts the crust of Japan in double jeopardy. Sometimes havoc comes on a large scale. So it was in 1923, when a portion of the crust suddenly snapped and slipped 100 feet along an extensive line. It brought violent death to 150,000 Japanese and caused terrible destruction in Tokyo and Yokohama.

The relationship of volcanoes and earthquakes is obscure. One seldom results from the other, yet there is evidence that in some mysterious way both are connected with the deep, hidden plumbing system beneath the thicker portions of the outer shell of the earth. There's no blueprint of this intricate arrangement of reservoirs, pipes, or connections that exist in that bewildering labyrinth. Only the surface manifestations are definitely known. In a volcano, the main outlet can be studied. From that, it is generally conceded that after eruption has ceased, the molten matter remaining in the vent or chimney often becomes hardened and acts as a cork sealing the upper portion. The thickness of such plugs varies and cannot be ascertained. Moreover, their lasting qualities are unknown.

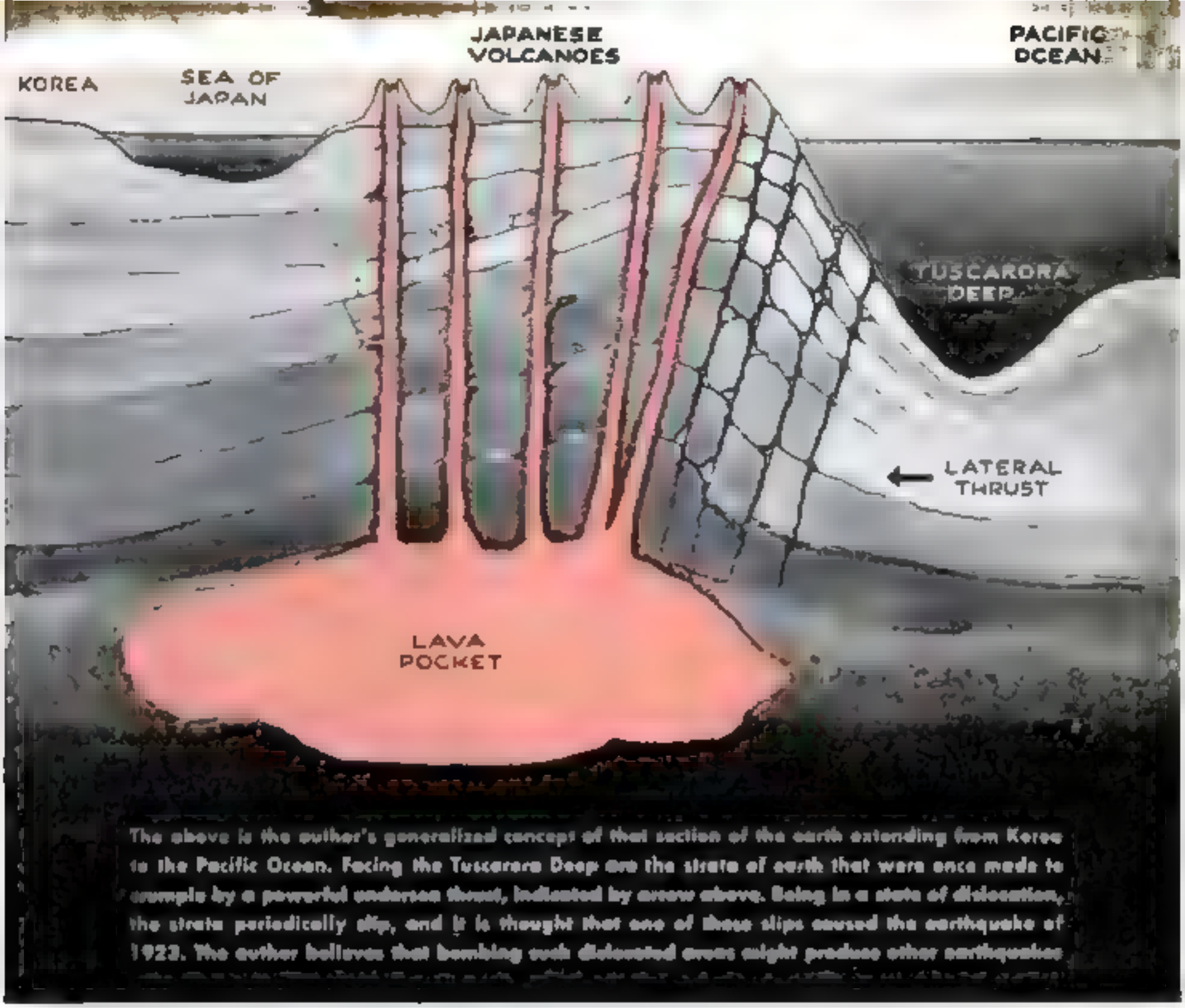
In a dormant volcano, gases and molten matter beneath the plug may be gathering again and exerting new pressure for a blowout. Should it be that the time for an eruption is near, it is quite within the realm of possibility that a raid on the crater with block-busting bombs might be the force to set it off. Applying the same argument to earthquakes, it is by no means unreasonable to suggest that a terrific jar produced at a time when an earthslip is in the making might accelerate the dislocation.



After an eruption, the molten matter remaining in the vent hardens and "corks" up the smoldering gases below. If this cork isn't too deep, a well-aimed bomb might considerably loosen it enough for another "blowout"

Because of their quaking land and treacherous volcanoes, the Japanese have produced some of the leading students of earthquakes and volcanoes. They know well the physical danger that constantly threatens their country. The Japanese Navy during target practice and battle maneuvers significantly moves far offshore. Some years after the earthquake of 1923, the U. S. fleet steamed into the waters of the bay between Tokyo and Yokohama. Japanese officials on shore radioed a request to this effect: "The Japanese Government requests that only the smaller guns be used in exchanging salutes. So sorry, please." These evidences of caution may add up to something

If the story broadcast from Berlin telling of the eruption of the big Japanese volcano Aso San after the Doolittle raid is true, it is safe to wager that the eruption caused



The above is the author's generalized concept of that section of the earth extending from Korea to the Pacific Ocean. Facing the Tuscarora Deep are the strata of earth that were once made to crumple by a powerful undersea thrust, indicated by arrow above. Being in a state of dislocation, the strata periodically slip, and it is thought that one of these slips caused the earthquake of 1923. The author believes that bombing such dislocated areas might produce other earthquakes

more jitters among the little people of the empire than did the bombing of Tokyo itself. Curiously enough, Nipponese officialdom was silent on the subject.

The idea of bombing volcanoes into activity and jarring the earth into earthquakes probably will be met with mingled derision and approval. Ultraconservative scientists, whose vision is often swathed in mathematical formulas, will snort, "Impossible!" while those with the imagination of Ben Franklin with his kite may murmur, "Could be, could be."

If all volcanoes were sealed tight to a great depth, no explosive now known to man would be able to crack the cork. Neither could any amount of surface pounding bring about a new dislocation in the earth's surface. But if the plug, like a slightly loosened cork in a champagne bottle, was about to blow because of pressure within—or if the earth's crust was in danger of becoming dislocated again owing to the force of internal strains—high explosives might well set off either delicate trigger months or even years before its natural time.

It is estimated that a bomb shelter capable of withstanding a hit by a 4,000-pound block-buster must have a cover of at least 100 feet of soil or 50 feet of solid rock. That, of course, doesn't mean the bomb could penetrate that far. But it does represent the approximate depth at which severe cracking would cause the collapse of the shelter. While there are no figures available as to the depth at which even bigger bombs would cause cracks, their effect would surely be felt farther down. Added to the depth of the zone fracture would be the extension of the shake-up.

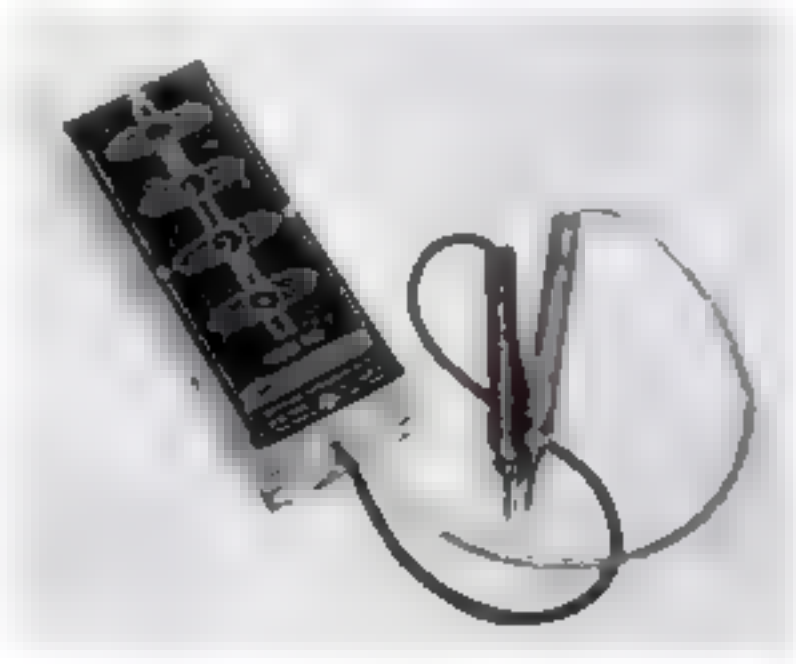
This we know. Two-ton bombs are being supplanted by much heavier ones, and it is likely that still newer bombs will make the original block-busters resemble exploding firecrackers. There is no reason why these superbombs shouldn't be tried on Japanese volcanoes. The targets are many, and the openings are wide. To those conservatives who may ridicule the suggestion, we toss a quotation from the eminent psychologist Dr. Albert E. Wiggam: "A conservative is one who believes that nothing should ever be done for the first time."

NEW Tools

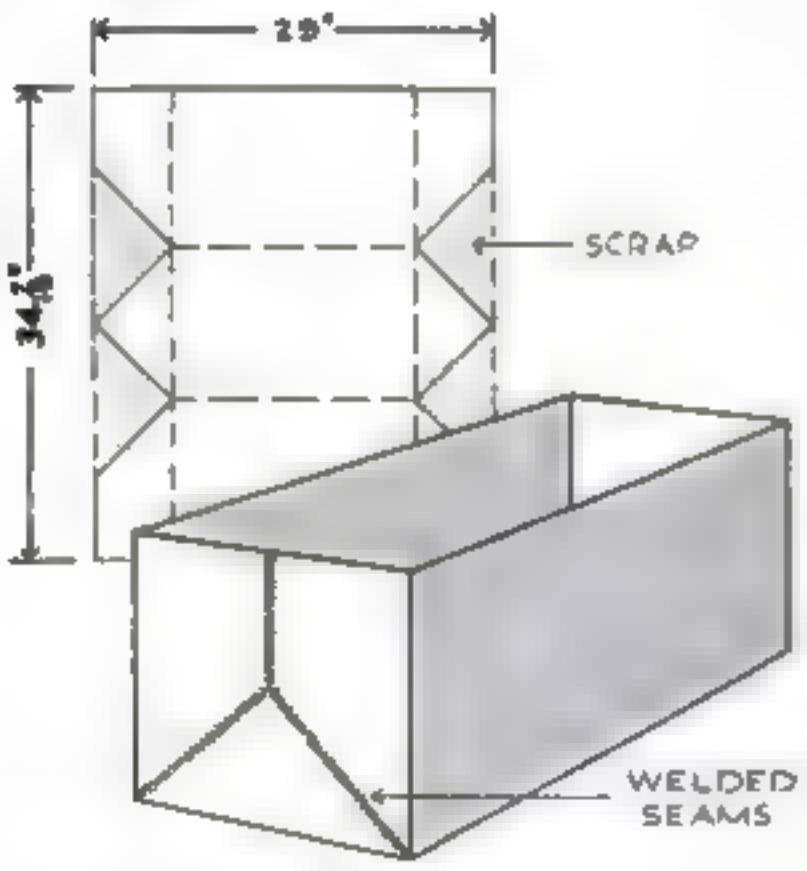
A DRAFTSMAN'S TOOL of Lumarith plastic has the important working feature of dimensional stability. Besides not registering effects of temperature and weather, the triangle is lightweight and transparent. Designed and patented by Earl J. Early, of Drexel Hill, Pa., the "Line-O-Graph" incorporates a ten-inch rule, straightedge, various angles, French curve, gradation markings, and holes for drawing parallel lines.

FOOT-PEDAL CONTROL of this rotary welding fixture, developed at General Motors, enables the operator to regulate the mechanism without interrupting his work. With the push-button control formerly used, he had to lift his shield each time he wished to stop the device. Now both his hands are free for work, while his foot controls the fixture.

A NEW VOLTAGE TESTER that reads like a thermometer is a versatile tool for all electrical maintenance in industry. When the needle-pointed prods are connected across any line, the tester indicates, among other things, the voltage, frequency, and type of current.



HERE IS THE SOLUTION OF THE BOX PROBLEM



Four small triangles of scrap mark the box pattern diagrammed above. The old pattern used at Westinghouse for making spare-parts boxes (see page 54) wasted four rectangles, requiring a sheet of aluminum 10½ feet square. Now a sheet 7½ feet square makes the same size box by this new, stronger, less costly design

Evaporation Cools Big Bomber Plant

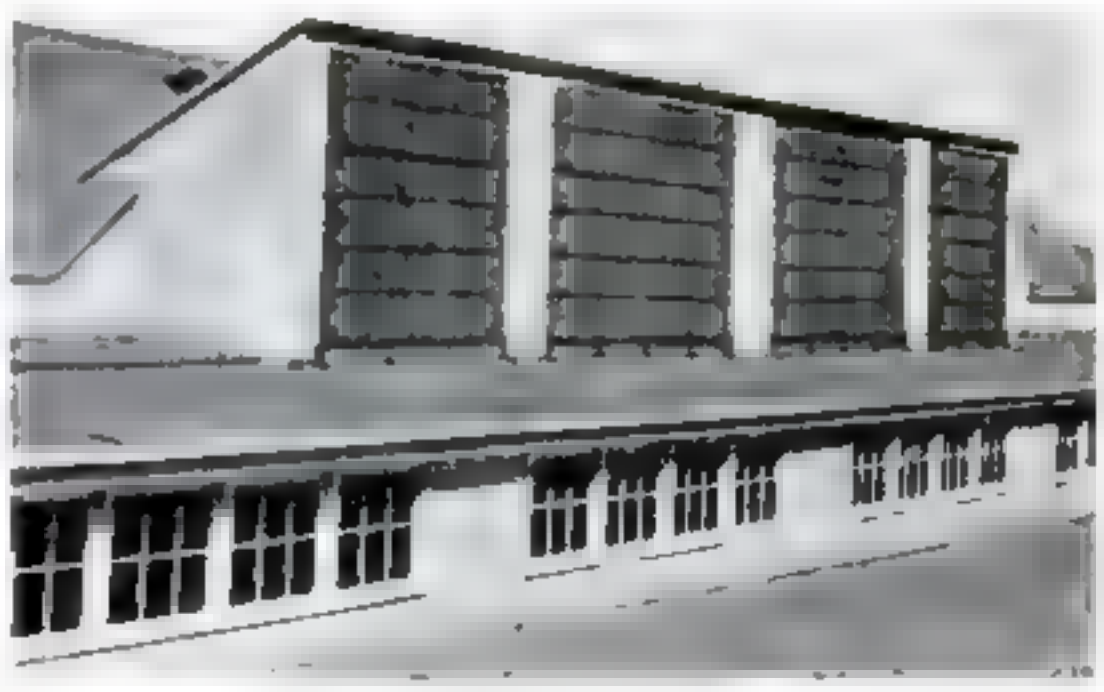
UNABLE to obtain standard air-conditioning units, engineers successfully lowered the temperature in Consolidated Vultee's sweltering Tucson, Ariz., hangars by reviving an old desert trick of cooling through evaporation. Workers now turn out Liberators in comfortable temperatures of 85 and 90 degrees while the mercury registers 105 outside.

Sheds on top of each hangar are set with huge pads of excelsior, which are overhung with perforated water pipes to keep them moist. Behind these lie fanlike blowers that suck in the dry air through the damp pads. Cooled 15 to 20 degrees through evaporation of the water, the air is then forced into all parts of the hangar through air ducts. The output of the entire system is 2,564,000 cubic feet a minute. Besides cooling, the pads also filter the air—very important in keeping instruments and engines dust-free.

Miniature pads and blowers are used to cool the interiors of Liberators stationed on the outdoor assembly line. Though not as effective as refrigerating units, the system of evaporative cooling, which has long been used in private homes of the Southwest, but never before on such a large scale, is highly satisfactory except on rainy days, when the air refuses to absorb extra moisture.

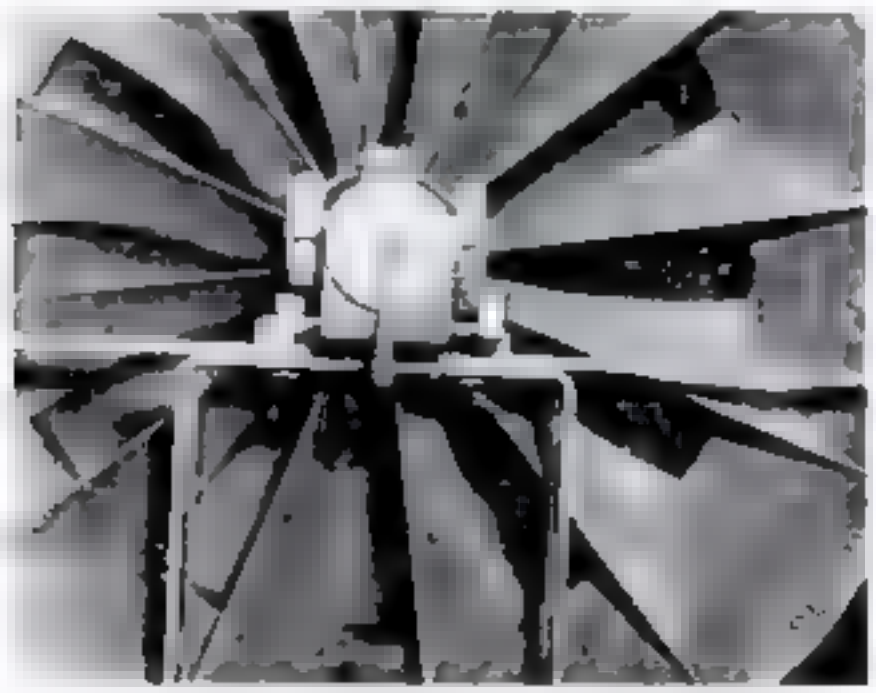
To cool drinking water in the arid Southwest, Indians use porous jars that let a little seep out and evaporate. This chills the jar and cools the water. The reason: The molecules that escape into the air are extra lively—far above average. So the ones that are left have . . .

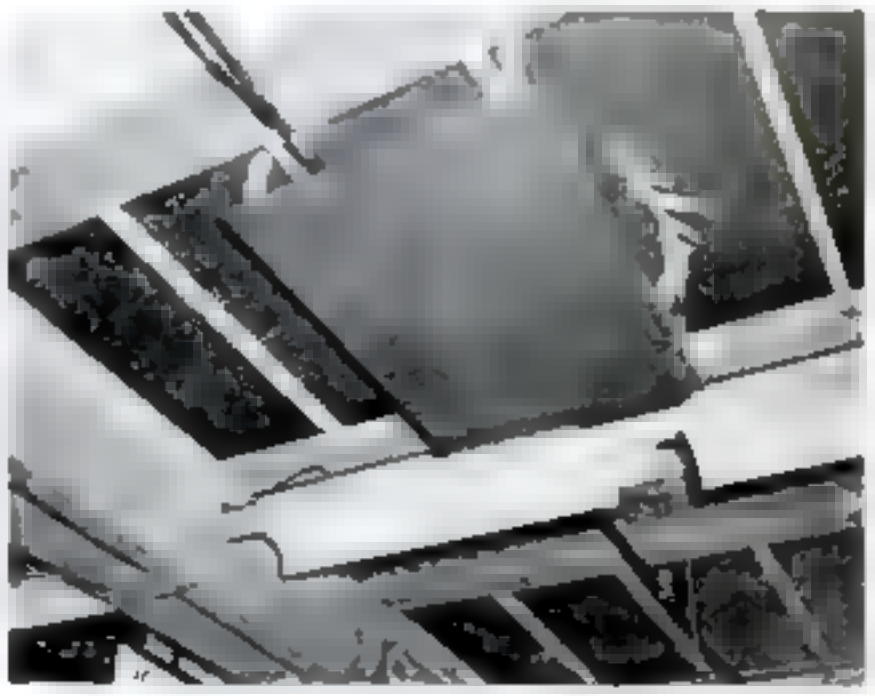
. . . a velocity below average. The less their velocity, the cooler the surface becomes. This is exactly what happens when you step out of a swimming pool and let a hot breeze evaporate the moisture from your skin. Now engineers use the idea to cool a desert bomber factory



Fans range in capacity from 22,500 to 65,000 cubic feet a minute. They change the air every four minutes in offices, eight minutes in hangars

Above, fan room faced with excelsior pads, kept constantly moist. Below, outlet and baffle in office ceiling. Paper strips indicate air flow





Coal to Our Rescue

We can forget our worries about dwindling oil supplies. Wartime research has found miraculous ways to get power and chemicals for a thousand years of better, richer life.

By ALBERT Q. MAISEL

DOES "coal age" sound dismal to you? Does it make you think of smoke, dust, soot, and shaking the clinkers out of the old furnace?

If it does, calm down and think again. For you are on the doorstep of a new coal age right now; in fact, you're more than halfway through the door.

It's going to be a richer, cleaner, healthier, easier-to-live-in age, too—thanks to what research chemists have discovered while applying coal to new war uses. We already get a large proportion—often a major proportion—of our power, our heat, our plastics, our industrial chemicals, our solvents, insecticides, tars, varnishes, paints, and even perfumes from coal or its derivatives. But that long list of present coal products is going to look short within the next couple of years. We'll get brand-new products that, today, are just a gleam in some laboratory chemist's eye—and many of our present coal-based commonplaces will become far more common and far cheaper than they have ever been before.

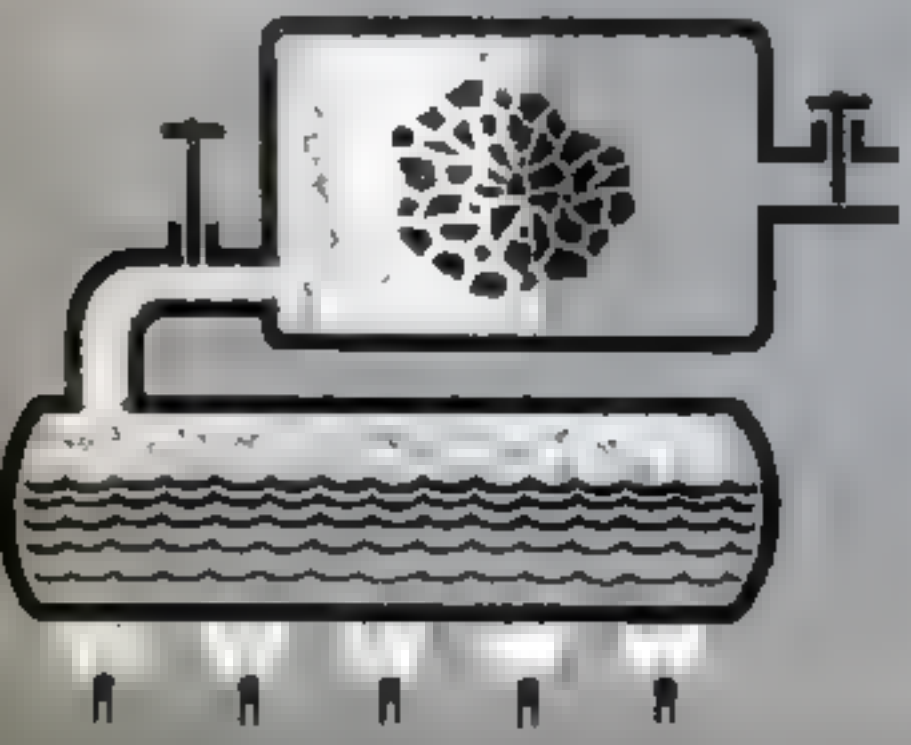
When you check up on some of the new coal processes, you find that a lot of them first began to be developed 20 or 30 years ago. But then along came our gushers of oil and our developments in oil cracking, making it possible to obtain competitive chemicals from oil far cheaper than the just-born coal processes could produce them. Now the war has taught us that our oil resources are not inexhaustible. In fact, at the present rate of consumption our proved reserves won't last much more than another 15 years or so. And new discoveries are lagging far behind consumption. Last year they replaced only 57 percent of the oil we used up. This means that we may be forced to turn to coal.

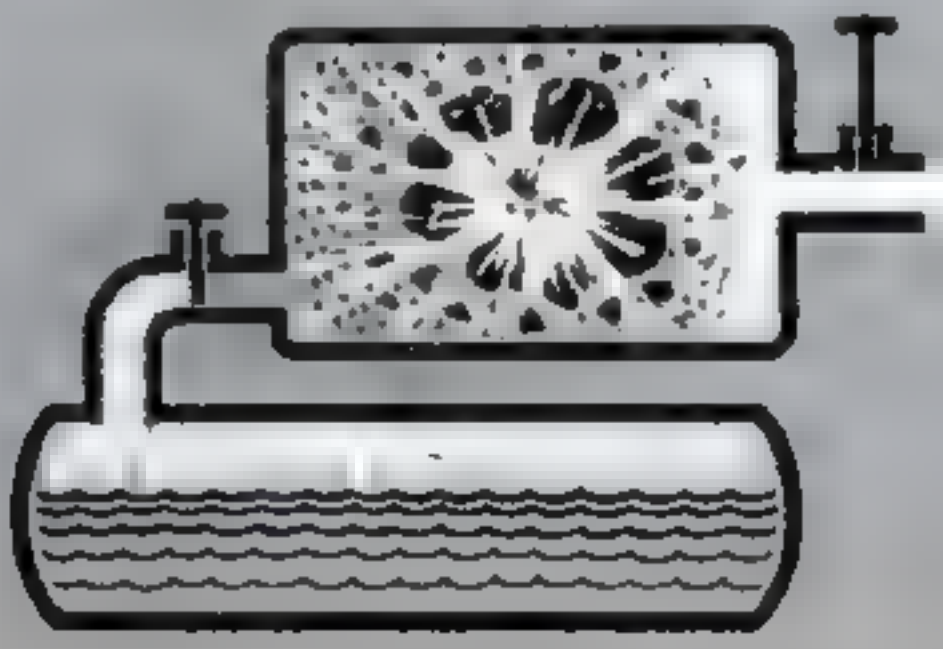
But don't get the idea that such a turn will be a total calamity. Right now, gasoline from coal costs somewhat more than does petroleum gasoline. But petroleum costs will go up while coal-processing costs are going down. So in the end, after a few years at most, you may be getting your gasoline as cheap or even cheaper than when you took it from the oil well. More important, you'll be sure of getting it, come what may. For we have 670 times as much coal in the ground as we have oil. At the present rate of use, our coal should last nearly 4,000 *(Continued on page 112)*

Like puffed rice, lumps of coal are exploded and pulverized by high-pressure steam. In this finely divided form, the coal can be piped to a furnace as readily and economically as liquid fuel or gas

Steam from a high-pressure boiler feeds into the coal filled pulverizing tube so that each pore of the coal is saturated to the very limit

When the tube's steam load is at peak a hydraulically operated valve releases it, and the pressure within the coal explodes it into dust

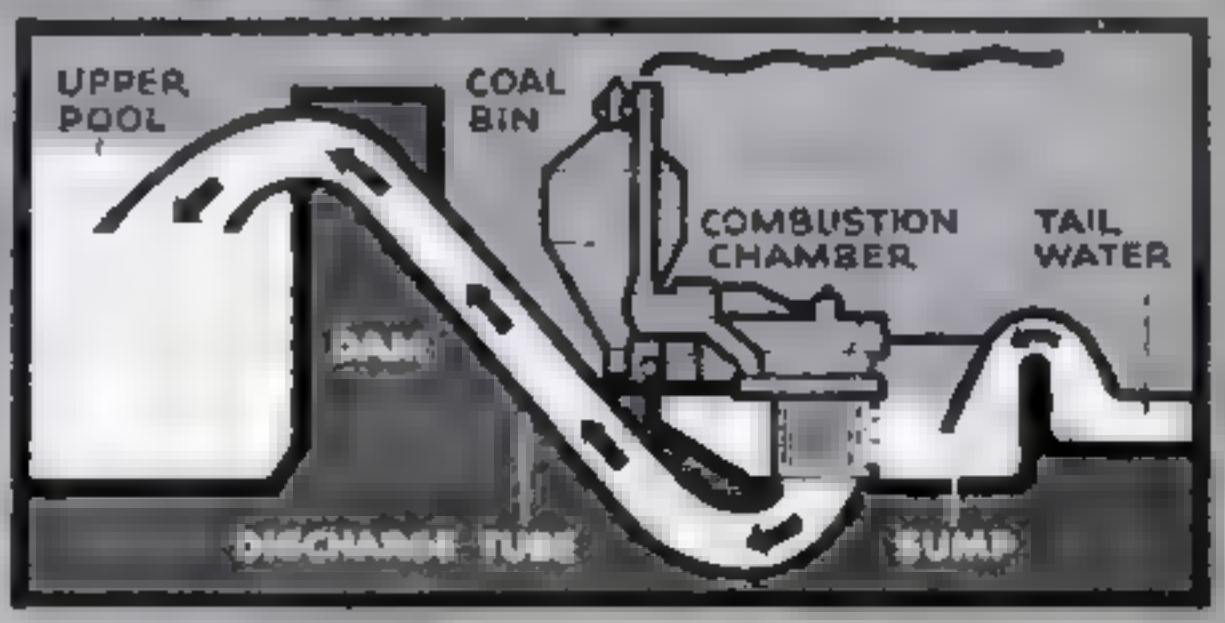




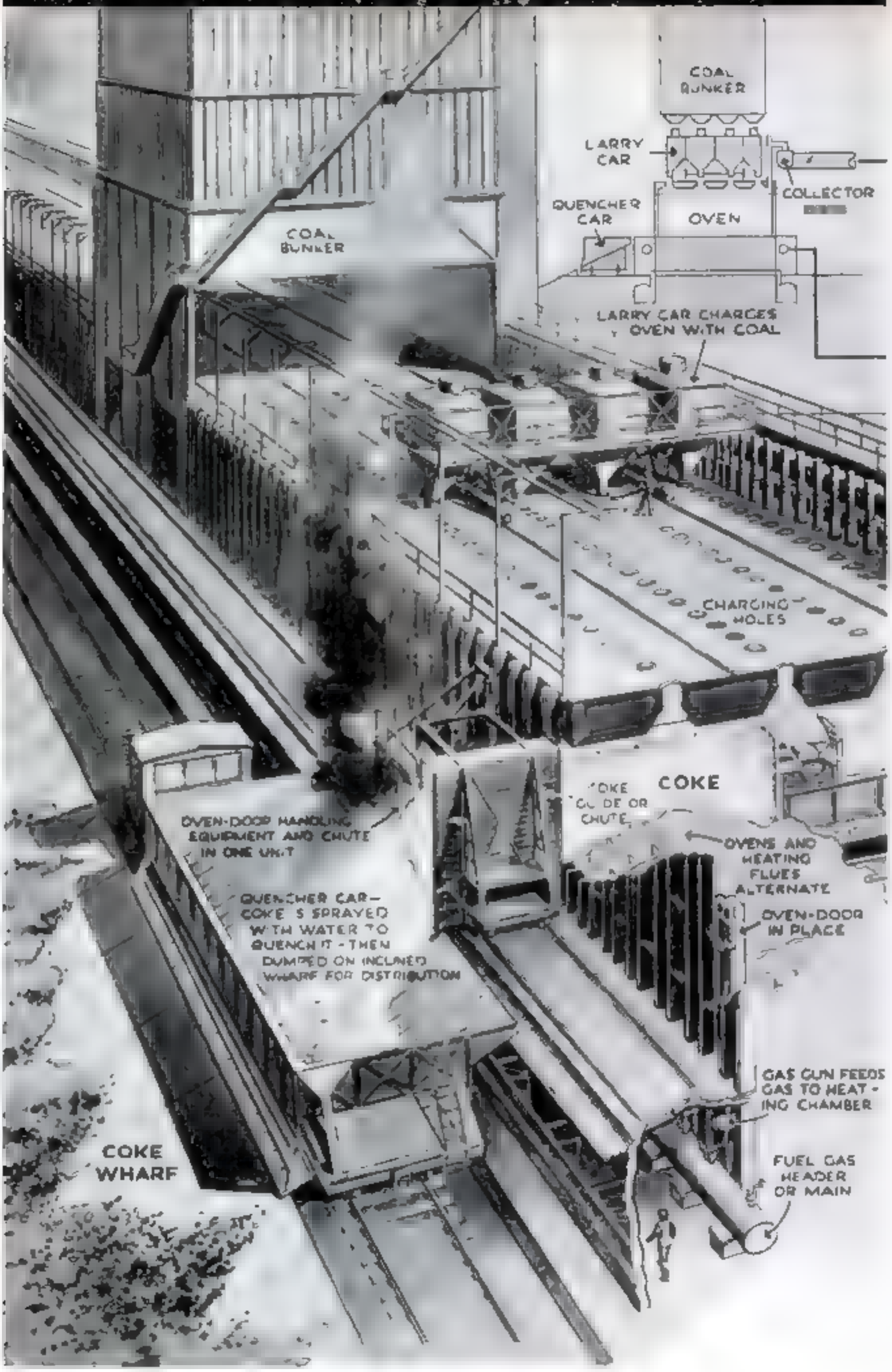
This modern by-product coke plant of the Carnegie Steel Co., at Clairton, Pa., converts coal into coke for blast furnaces, and pipes off coal gas from which countless valuable chemicals are obtained

Pulverized coal may prove a boon to hydroelectric power-generating and irrigating works by bringing into general use the Humphrey pump, which can raise water back over a dam to replenish the reservoir

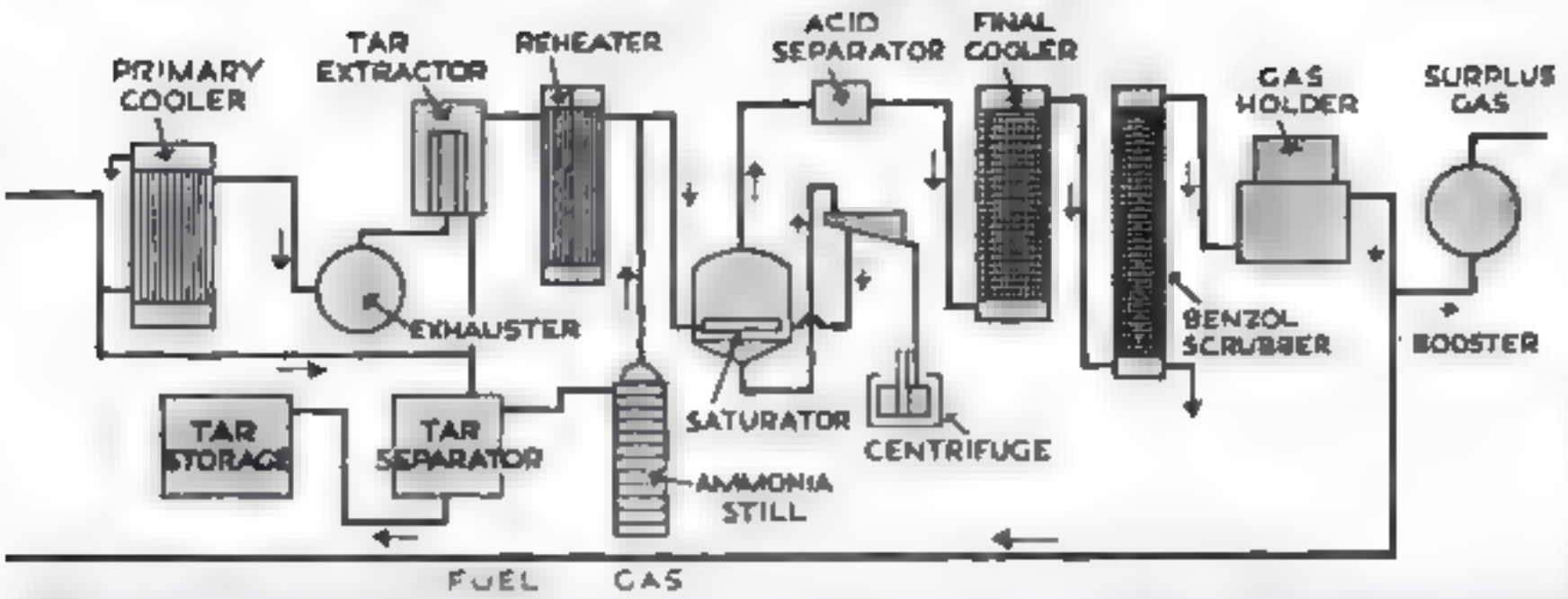
A mixture of pulverized coal and air is ignited in the cylinder of the Humphrey pump. The resulting explosion rams a column of water down the cylinder and into the U shaped tube, which takes the water back over the dam into the supply pool. Water remaining in the discharge tube runs back, clears out combustion gases, and compresses a new fuel mixture, as inlet valves admit the following charge of water

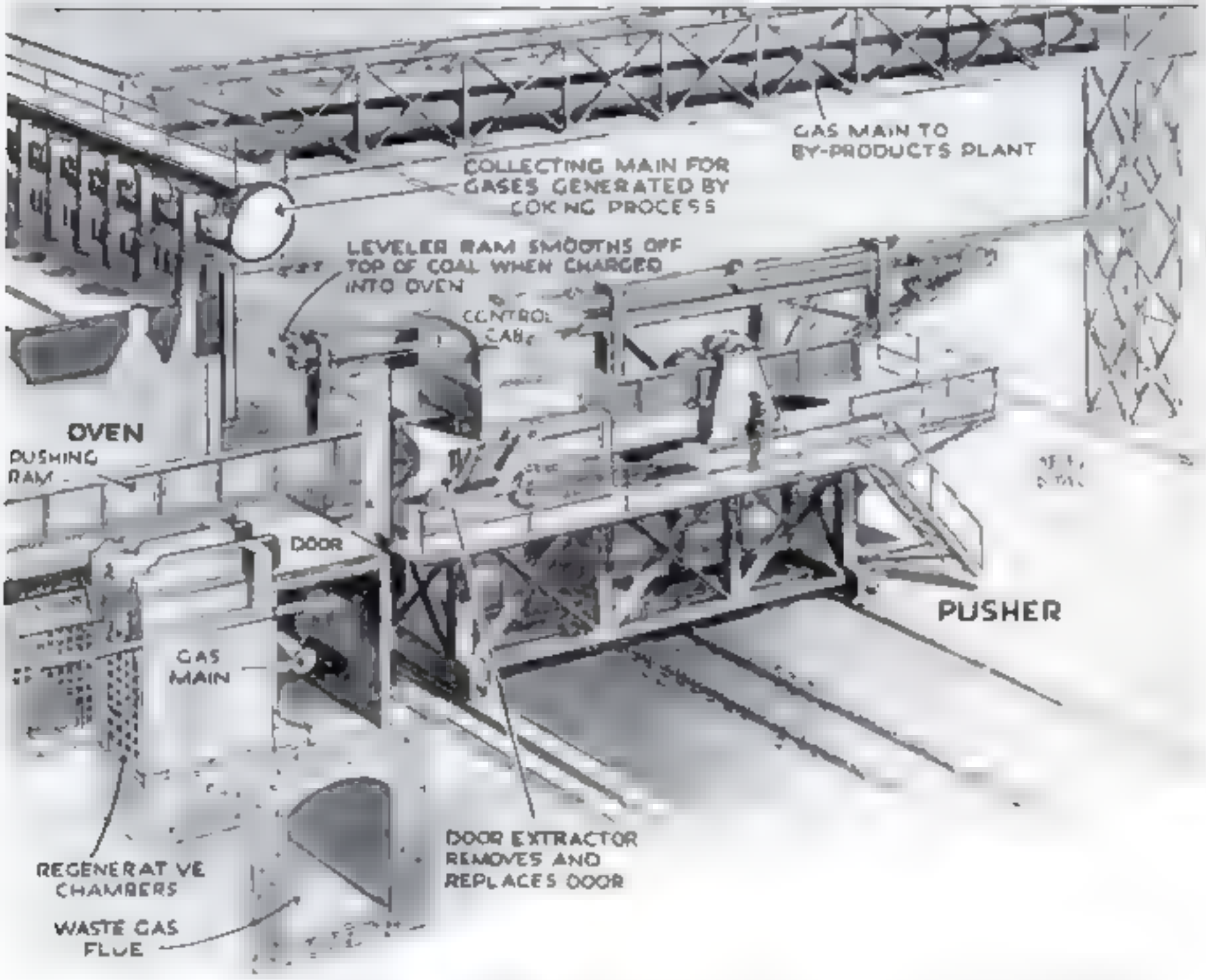


Battery of Ovens in Action



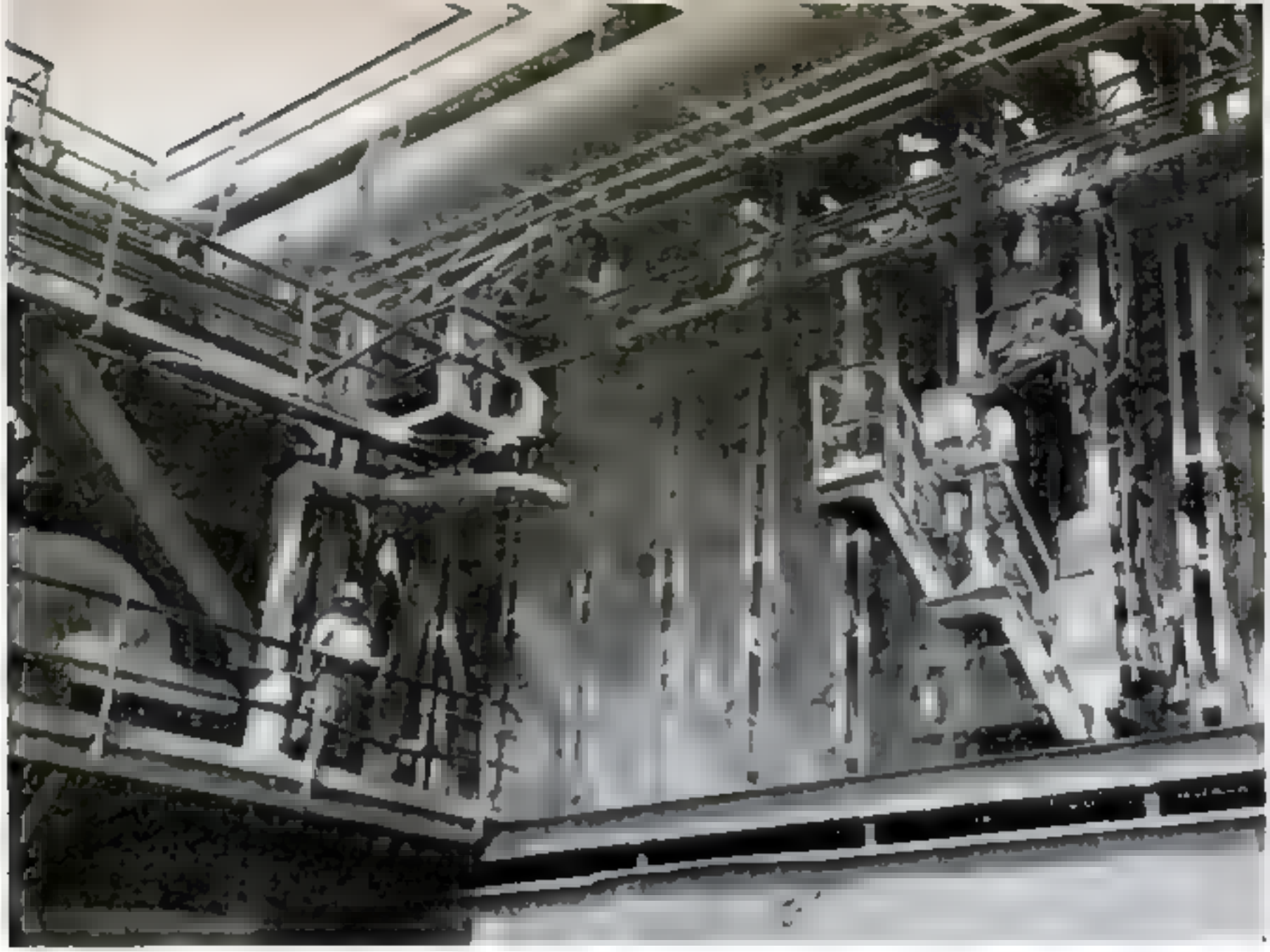
Making Coke for Steel and By-Products





ABOUT ONE MINUTE IS REQUIRED TO PUSH A CHARGE OF COKE OUT OF OVEN

Filled from a coal bunker by an electrically propelled larry car, this battery of coke ovens supplies fuel for the blast furnaces of a steel plant. Each individual oven is 144 feet long, 12 feet high, and less than two feet wide. A traveling pusher ejects its 2-ton charge after about 17 hours of coking. Coal gas, driven off in the heating, yields valuable materials in a by-products plant (diagram in insert at top)



The "pushing machine" at left lifts off the end door of an oven, rams out the coke, and replaces the door. An electrically operated "luting buggy" (right) then seals the door with clay

years. Even if we quadruple that use, we still won't have to worry about running short for at least a thousand years.

One nice thing about getting gasoline—and other things now derived from petroleum—from coal is that we won't run into regional shortages again. Coal, despite temporary shortages in production, is available in more than 30 of the 48 states, so we won't have to think about safe routes for tankers or about building new oil lines.

But gasoline from coal, important as this may be to a ration-conscious America, isn't the only new thing that is coming our way from the coal mines. We're already beginning to use some new coal fuels, and we're going to use them a lot more in the future. For instance, there is so-called "fluid coal." This is a special form of pulverized coal that is mixed with air and then made to flow through standard pipe systems, sometimes a quarter of a mile or more in length. The Columbus Bolt Works has used one of these furnaces, developed by the Battelle Memorial Institute, Columbus, Ohio, one of our major coal-research laboratories. And it did its forge-heating work at only one sixth of the cost of the oil-heated furnaces in the same plant.

Even so, the use of "fluid," or pulverized, coal might not be too desirable if another group of researchers, at the Armour Research Foundation this time, had not found a way to pulverize coal by steam explosion, a method similar to that by which puffed rice is "shot from guns," as the ads used to say. The lumps of coal, direct from the mine, are fed into a pulverizing pressure tube fed from a high-pressure steam boiler and equipped with a hydraulically operated, quick-opening valve. Steam, admitted under pressure into the gun, soaks into the pores of the coal. Then the hydraulic valve releases the pressure automatically and—presto—the pressure within the pores of the coal causes it to explode into millions of tiny particles.

Curiously enough, the process serves to clean the coal at the same time. This occurs because the impurities, such as bone and pyrites, are much less porous than the coal substance. Hence these impurities break into larger pieces and can be separated from the pulverized coal by a simple screening process.

Like the "fluid" coal development, colloidal coal was experimented with back in 1917 and 1918, but was dropped because of oil competition during the last war. Today colloidal coal—a mixture of oil and powdered coal—is again proposed. It can save more than 30 percent of oil consumption. And it is particularly handy because it doesn't require the rebuilding of large furnaces, such

as those in power plants, which were originally designed for oil and have no ash pits and grates.

Pulverized coal may be called upon to bring about a rebirth of the Humphrey pump, a unique type of engine designed over 30 years ago but still used only in its original installation. The power to operate it is generated in the same cylinder serving to pump the water; it is thus an internal-combustion engine and a pump combined. But instead of actuating a metal piston, as in ordinary engines, the explosion pushes up a column of water, which is discharged at a higher level.

The pump is shaped like a U tube with one leg much longer than the other, in fact extending 40 to 60 feet above to the discharge end. The short side is a closed end and is the head of the engine. Inlet valves admit a charge of water into the lower part at the proper time, which is just before the water remaining in the discharge tube starts to back down at the end of the power stroke. The returning water scavenges the combustion gases and compresses the new fuel-air mixture introduced meanwhile through the head. Ignition of the charge causes the cycle to be repeated automatically

The original Humphrey pumps, still in use on the River Lee in England, operate on producer gas, a rather expensive fuel. It is now proposed that pulverized coal be substituted for gas in order to lower operating costs and, quite probably, improve the overall efficiency of the pumping operation.

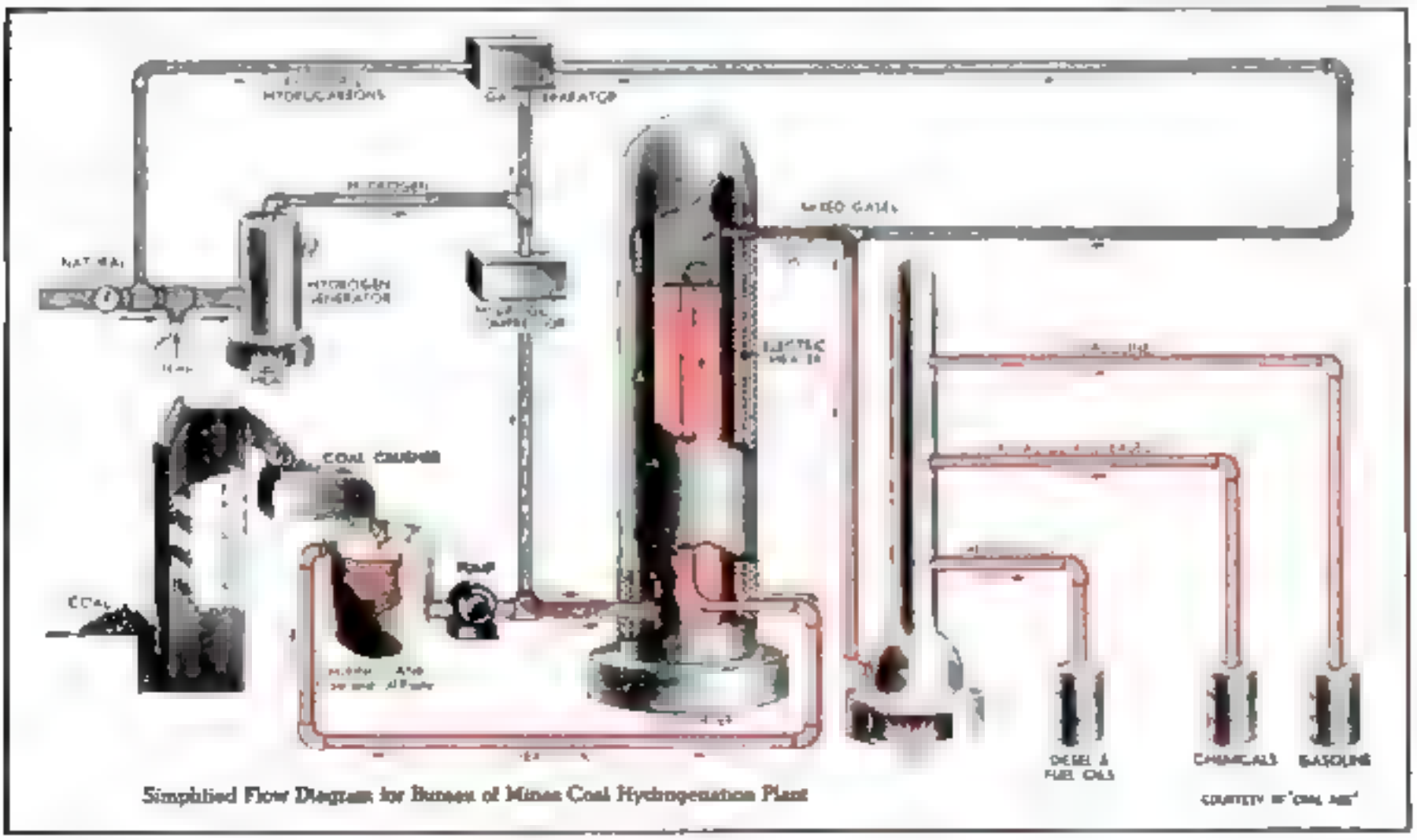
In connection with hydroelectric generating plants, the use of Humphrey pumps, placed alongside of the dam, would accomplish two useful and economic services. First, judicious use of the pumps over the various seasons would compensate for the vagaries of rainfall and fluctuations of river flow by making it possible to pump water from the tailrace of the turbogenerators back to the reservoir for use over and over again. Thus the average power output of the plant could be put on a continuous basis, unaffected by flood or drought. Second, the combination of a storage reservoir for the water together with the pumps makes it possible to meet daily peak loads by drawing on the reserve water without the necessity of providing corresponding pump capacity. For use in waterworks and irrigation, the simplicity of the Humphrey pump holds great promise as a further application of pulverized coal.

By no means is all our coal consumption today accounted for by its use as a fuel. And in the future, despite the new ways of "burning" or exploding coal, we shall probably use a still larger percentage than we now do for making products out of coal

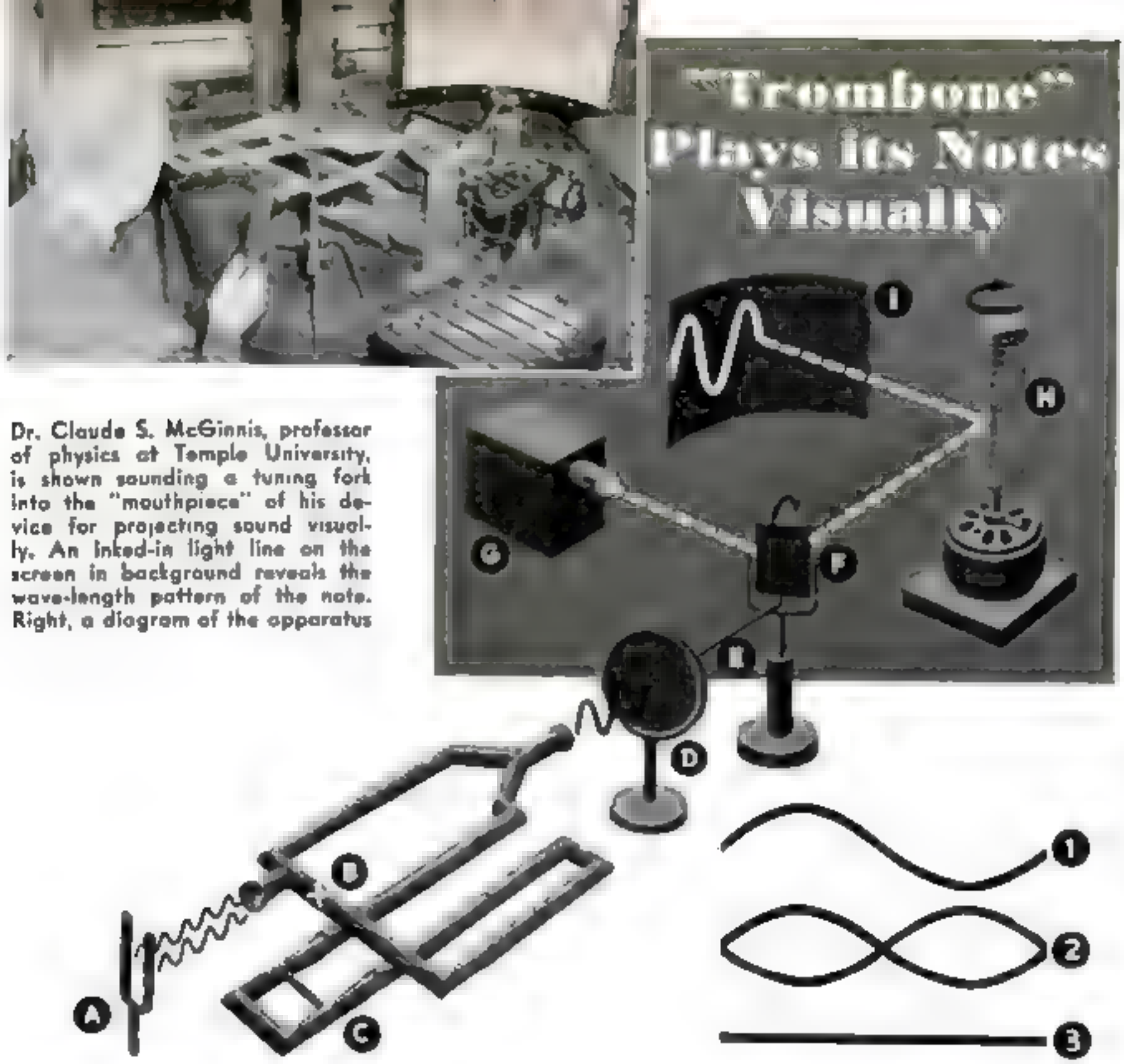
Most of our coal chemicals are obtained today by an indirect process in which we first *carbonize* the coal into coke and take off tars which yield dyes, drugs, and a host of other chemicals. Then we process the coke further to *(Continued on page 184)*

HOW COAL IS CONVERTED INTO GASOLINE

Courtesy of "Coal Age"



Simplified Flow Diagram for Bureau of Mines Coal Hydrogenation Plant



Dr. Claude S. McGinnis, professor of physics at Temple University, is shown sounding a tuning fork into the "mouthpiece" of his device for projecting sound visually. An inked-in light line on the screen in background reveals the wave-length pattern of the note. Right, a diagram of the apparatus

AN INGENIOUS "slide trombone" device that projects sound waves visually on a screen has been developed by Dr. Claude S. McGinnis, head of the department of physics at Temple University, Philadelphia, so that his students may study sound by seeing it as well as hearing it. Ordinarily, an electronic oscillograph, employing a cathode-ray tube, is required for this purpose. This latter instrument, however, is suitable only for definite wave lengths, while Dr. McGinnis's device can be used to project sounds of any wave length without adjustment.

Considering the function it performs, the device, which is diagrammed above, is amazingly simple. When a tuning fork *A* is sounded at the "mouthpiece" and the valve at *B* is closed, the musical tone travels through the short tube at the left of the mouthpiece to a thin steel diaphragm *D*. So sensitive is this diaphragm that it will respond to all sound waves entering the mouthpiece, irrespective of their frequencies. From the center of the diaphragm runs a cocoon fiber *E*, through which the sound vibrations pass to oscillate a bearing-mounted mirror *F* on its horizontal "axle." A powerful pin-point beam of light emitted from *G* is then picked up by the small vibrating mirror and reflected to *H*, composed of four rectangular mirrors set edge to edge and made to revolve at a controlled speed. From *H* the light beam is projected on a screen *(1)* in a series of light dots, which follow each other so rapidly that the observer sees what appears to be a continuous curved line, such as is shown at *1*, above.

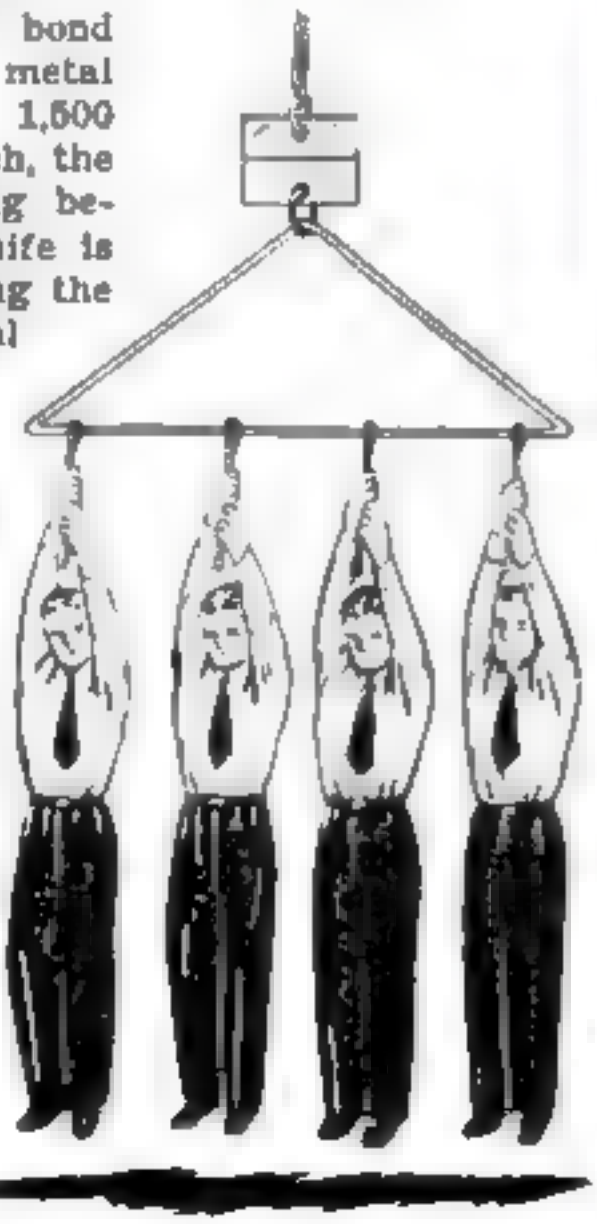
Now suppose that the valve at *B* is opened. The musical tone will then travel through both legs of the trombone before reaching the diaphragm *D*. If the slide *C* is properly adjusted, the crest of one sound wave will coincide with the trough of the other, as illustrated in *2*, and the two will cancel each other. What will then appear on the screen will be a straight line *(3)*, showing that the two sounds have merged into silence! So intense is the beam of light that in a room lit in ordinary fashion the wave pattern can be seen on the screen. For a photographic record, sensitized paper is used as a screen.

Adhesive Is Stronger Than Materials Joined

A NEW bonding process that unites metals with extreme firmness, and joins rubber, plastics, leather, or wood to metal, or to each other, with a bond stronger than the materials themselves, has just been made commercially available by the United States Stoneware Company, of New York. Known as the Reanite process, it is already finding vital war uses in the fabrication of airplane subassemblies, shock-resisting motor mounts, sound and vibration-dampener units, instrument mounts, and in bonding rubber or plastic insulation to wire or cable. It is expected to find hundreds of peacetime applications when available for general use.

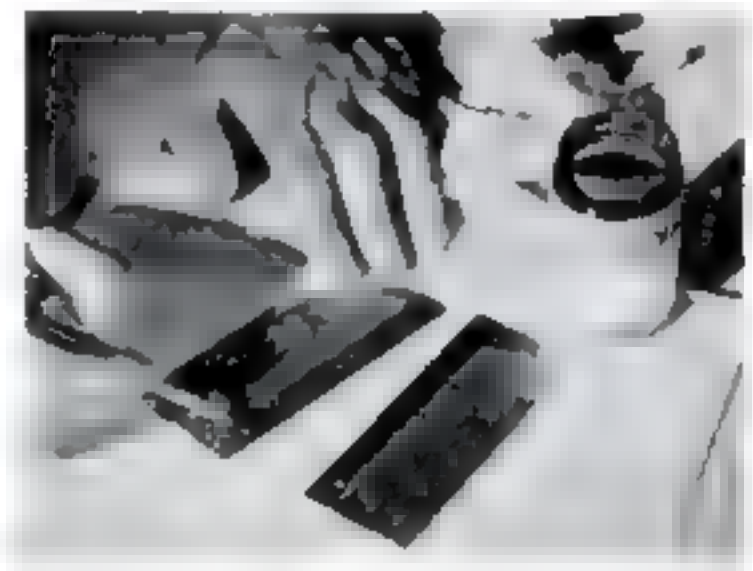
One of the major features of Reanite is its ability to unite dissimilar materials, enabling full use of the individual physical properties of each. For instance, thin sheets of stainless steel or aluminum can be bonded to chemically impregnated plywood to form lightweight, fire-resistant, waterproof structural assemblies, which can, in turn, be formed into prefabricated housing units, boats, airplane or motorcar assemblies, kitchen cabinets, and furniture.

Application of the process is simple. The surfaces to be joined are brushed, sprayed, or dipped with Reanite. After drying, mild heat and pressure are applied. With standard testing machinery it was found that a Reanite bond between metals would stand a direct pull of from 1,000 to 3,000 pounds per square inch before breaking. The bond between rubber and metal runs from 900 to 1,500 pounds per square inch, the rubber itself breaking before the bond. A knife is required for separating the rubber from the metal



In a test of the adhering strength of Reanite, four 150-pound men were suspended from the lower of two pieces of aluminum bonded with Reanite. The results are seen at far right

1 In using Reanite, surfaces to be joined should first be washed thoroughly with soap and water, or other cleansing agent



2 The liquid Reanite can then be sprayed or brushed on the surfaces. Parts should be allowed to set until they are well dried

3 After the dried surfaces are joined, the Reanite is set chemically by applying a firm pressure and a heat of 290 degrees F.

Above are the two pieces of bonded aluminum used in test at left. Note how metal has broken while bond has remained intact

AIDS TO

Modern Living

ALUMINUM YARN will be used in a variety of postwar fabrics if further experiments bear out the promise of laboratory tests made on the new material. The girl shown above is wearing an evening sweater of shimmering, golden-hued mesh woven entirely of aluminum yarn. One pound of aluminum can be spun into 33,000' of yarn and still retain great tensile strength. The yarn is washable, and it will come in various colors

ICE-CUBE TRAYS made of light, transparent plastic, like the one below, prevent the cubes from absorbing an unpleasant, metallic taste, no matter how long they may remain in the freezing compartment. Another advantage of this new type of tray is the ease with which it can be removed from the freezing unit. The shape of the ice cubes formed in this tray is such that they can be extracted as needed with little trouble

GRAVY WON'T LUMP if thickening is blended by being swirled about inside a patented glass mixer such as the one above, declare the makers. Contours in the base and the plastic top of the mixer impart an action producing a smooth paste when ingredients are shaken against them for a few seconds. Markings on one side of the mixer make it also useful as a measuring cup. A bead around the top of the glass effectively prevents leakage

STORING FABRICS in a dark, moderately cool place is recommended by textile experts of the U. S. Department of Agriculture, who conducted a four-year test on cottons, linens, and woolens stored at differing temperatures that ranged up to 102 deg., which was regarded as the summertime heat of the average attic. Although changes in the fabrics in hot storage were not great enough to render them unserviceable, they did show more deterioration than those stored in cooler places. In hot storage, cottons and linens yellowed, and some fabrics weakened. Light seemed to affect the textiles more than heat, for lesser chemical changes were noted when all light was excluded

THIS WASHING SOLUTION is so concentrated that it takes but a small amount in a pail of water to make the dirt fly, according to the manufacturers. Autos washed with it will gleam without polishing, say its sponsors, and like results can be obtained on windows and other hard surfaces of high sheen. The solution is also hailed as a saver of labor, since articles cleaned in it are easy to rinse, and need no drying

INSECT SPRAY GUNS now being manufactured of wood, paper, glass, and plastics have proved to be as durable and efficient instruments as those formerly made of metal. The tough constituents will withstand long submersion in various kinds of insecticides, while acetone joining of their plastic parts provides as much strength as the soldered joints of the old-type metal sprayers. Lightness is an added advantage of the new guns

A CREAM HAND SOAP devoid of harsh chemicals is being used by the girl worker below to remove factory grime. Possessing an antiseptic quality that guards against infection, the soap combines lanolin and other oils with granules of calcium that rout out imbedded dirt, yet leave the hands soft and unscratched. It gives a good lather in cold water as well as hot, and will cleanse as effectively as many of the abrasive-type soaps

FRUIT-JAR SEALS of a pliable plastic have recently been placed upon the market in a design intended for use on a special glass jar and top. The new seal fits around and slightly above the top of the jar. The rim of the cover, beveled on the inside, compresses the seal and molds it over the top edges of the jar when pressed down firmly. Glass does not touch glass at any spot, and no clamps are required for a perfectly airtight seal

ENAMEL THAT DRIES HARD IN ONE HOUR is now made. It will cover some jobs when one coat is applied either with a brush or spray gun. Resistant to boiling water, alkali, alcohol, and acid, the enamel wears well as an interior finish on floors, tables, breakfast-bar tops, chairs, and other woodwork. As an exterior finish it can be used also in clear form on doors, sash, and boats

preferably a noninflammable one, on flat and pile fabrics. Soap and water may sometimes be used in general cleaning of pile, but be sure that the soap is nonalkaline and always have more suds than water. Badly pressed-down pile can be refreshed by steaming with a hot flatiron touched lightly to a damp cloth laid over the surface of the fabric, or by the repeated applications of steaming hot cloths. While the upholstery is still damp, brush it lightly with a whisk broom, and brush it again when it has dried.

Leathers may be washed with thin suds of lukewarm water.

Helping Auto Upholstery

WHAT TO DO ABOUT UNSIGHTLY STAINS THAT CAN'T BE AVOIDED

By RALPH ROGERS

MANY a car owner is like the proverbial housewife who swept dirt under the carpet. In the case of the car owner, scrupulous care is often given to the motor and the body is kept spotlessly washed and polished, but once the door is opened the auto has somewhat the appearance of an unmade bed.

Granted that keeping the mechanical parts of a car in good condition is more important and that all the attention in the world to the upholstery won't make the engine run better, yet you may be surprised at the uplift in spirits a clean car interior can bring—as well as the sizable reduction it can make in your personal cleaning bill at the tailor's.

Use of a whisk broom is all that is necessary most of the time, but occasionally a more thorough job should be done with a vacuum cleaner or an old-fashioned carpet beater. Seats should, of course, be removed when a carpet beater is used to knock out the dust. This isn't always necessary with a vacuum cleaner, but even then removal of the seats will permit better cleaning of the corners under them

Flat-woven cloth, pile fabrics, and leathers are generally the basic types of fabrics used for automobile upholstery. If dirt is imbedded too deeply for removal by a vacuum cleaner, apply a volatile cleaner, Use a nonalkaline soap. The surface should then be wiped with a damp cloth containing no soap and finally wiped dry with a soft, dry cloth.

On occasion the upholstery may be soiled in spots by some matter other than ordinary dirt and dust. These various accidental stains require special treatment and should be removed as quickly as possible after they have been noted. A number of specific cleaning instructions are contained in booklets published by General Motors and Chrysler. In some instances, especially when water is required, there may be discoloration of the upholstery involved in the cleaning, but often this will be preferable to allowing the stain to remain. Always use clean cloths, change frequently to clean parts of the cloth, and use as many cloths as necessary.

Battery Acids. Soak the spot with household ammonia for about a minute so that the acid will be neutralized, and then wash off the place with a clean cloth and cold water. If the acid is allowed to remain on the fabric, it will eat away the fibers.

GREASE

Blood. Rubbing with a clean cloth and cold water is often sufficient. If some of the stain remains, apply a little household ammonia and water and, after a minute or so, rub again with a wet cloth. If this is not sufficient, apply a paste of corn starch and cold water. Pick and brush off the starch when it has dried. Several applica-

tions may be necessary. Never use hot water or soap on blood spots, for they will set the stain and make removal virtually impossible.

Candy. Stains from candy other than chocolate should be rubbed with a cloth dipped in very hot water. If any of the stain remains after the fabric has dried, sponge with carbon tetrachloride. Chocolate spots are rubbed with lukewarm water, and then sponged with carbon tetrachloride after the upholstery has dried.

Chewing Gum and Tar. Moisten the gum or tar with carbon tetrachloride and scrape with a dull knife before it dries.

Fruit, Liquor, and Wine. Try rubbing first with lukewarm water, scraping, if necessary, with a dull knife. If this does not remove the stain, use hot water, but remember that hot water itself may cause some discoloration. After the fabric has dried, sponge with carbon tetrachloride if any stain still remains. Do not use soap, as it may set the stain.

Grease and Oil. Scrape first with a dull knife, and then sponge and rub with carbon tetrachloride. Dirt contained in the grease may remain on the fabric and can be removed with lukewarm soapy water, which should then be rinsed off with a clean damp cloth.

FRUIT

Ice Cream. Treat first as a fruit stain, which may be sufficient. In persistent cases, follow by rubbing with warm soapsuds, and then rinse out the soap. When this has dried, sponging with carbon tetrachloride will remove any fatty matter that remains.

ICE CREAM

Ink and Iron Rust. Iron rust requires initial rubbing with warm soapsuds and rinsing with cold water. When the fabric has dried, it is treated the same as ink. For this use iron-rust soap, ink eradicator, a saturated solution of oxalic acid, or a two-percent solution of sodium bifluoride. These are usually efficient in the order listed. The composition of writing inks varies, however, and it is impossible to find an agent equally effective for all. Ink rarely can be completely removed from velvets and flat fabrics without injuring the material.

Rub the iron-rust soap in the spot with the fingers and, after a minute, wipe it off with a dry cloth, repeating until the wiping cloth no longer shows a stain; then rub with cold water. In applying ink eradicator, always use the No. 1 solution, since the No. 2 will change the color of the fabric. Put ink eradicator, oxalic acid, or sodium bifluoride on the upholstery with an eye dropper and blot with blotting paper, repeating until a clean portion of the blotting paper shows no stain; then rinse by rubbing with cold water.

HAIR

Lipstick. Apply carbon tetrachloride to the spot and blot with blotting paper, repeating until the stain is removed.

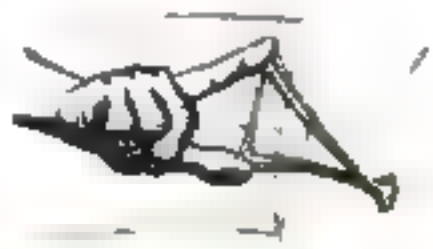
Mildew. Rub vigorously with warm soapsuds and then rinse. Old mildew may leave a stain that cannot be completely removed. Try soaking with a 10-percent solution of oxalic acid, removing the acid after a minute by alternate blotting and pouring on of hot and cold water.

Nausea. Sponge with cold water before the stain has had a chance to dry; then wash with lukewarm suds and rinse. Use carbon tetrachloride on any remaining stain.

Paint. Rub with turpentine or a half-and-half mixture of denatured alcohol and benzene before the paint has dried. Saturate dry stains with the alcohol-benzene mixture and work out as much paint as possible with a dull knife. Repeat this several times; then rub with lukewarm suds and rinse.

Shoe Polish. Use carbon tetrachloride on black or tan polish. White polish can often be brushed off; if not, use cold water, let it dry, and brush again.

Urine. Sponge with lukewarm soapsuds and rinse with cold water; then rub the surface with a solution composed of one part household ammonia and five parts water. Let this remain for a minute, and then rinse with a clean wet cloth.



GUM

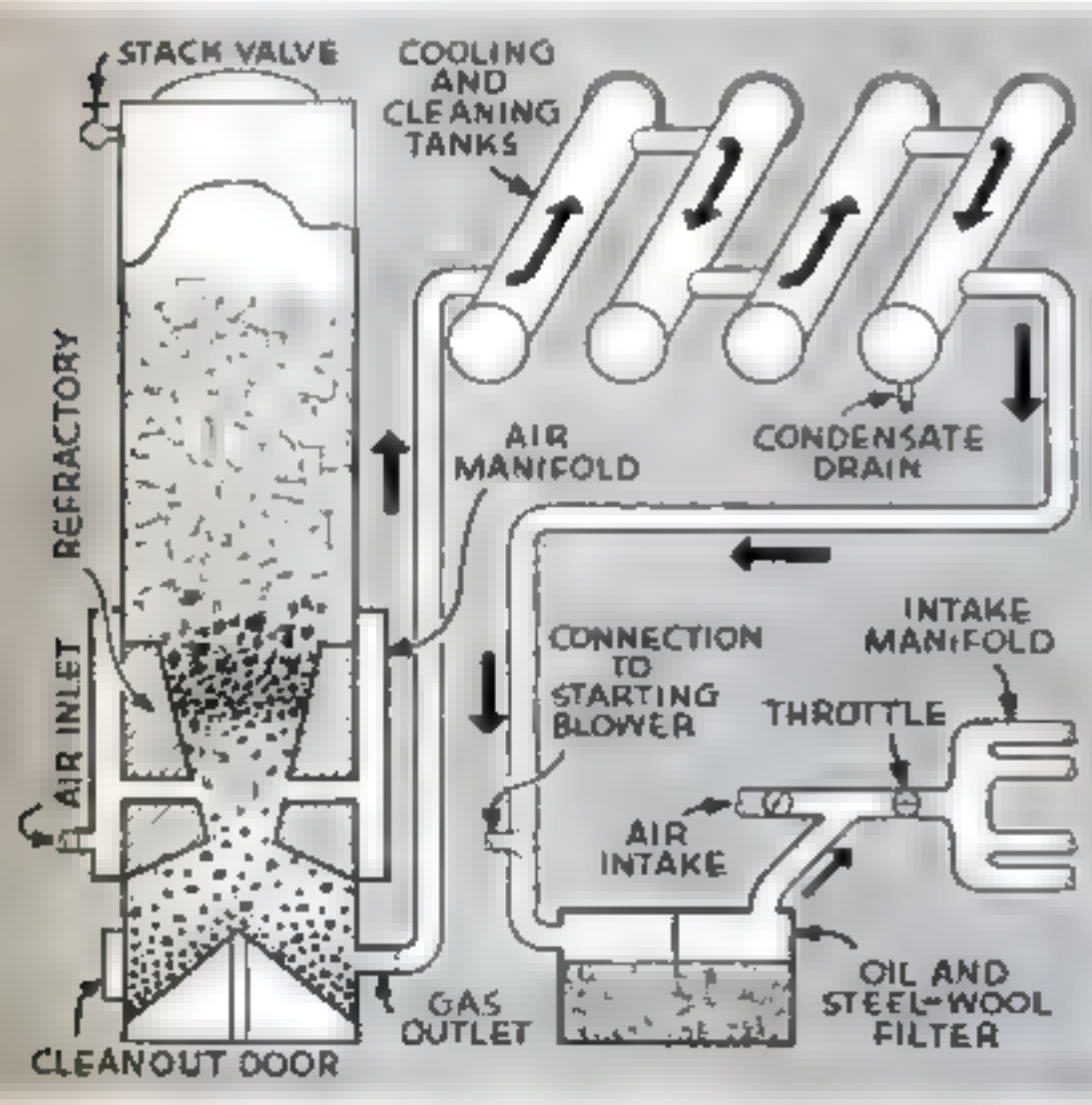
Water spots. Sponge the entire panel of upholstery with cold water; then rub with carbon tetrachloride.

Keep That New-Car Look

"Fill her up with half a cord of oak..."

Can We Use Wood to

Brewery superintendent Herman Reese adds wood to the hopper of the first truck he converted. Below, a diagram of the producer

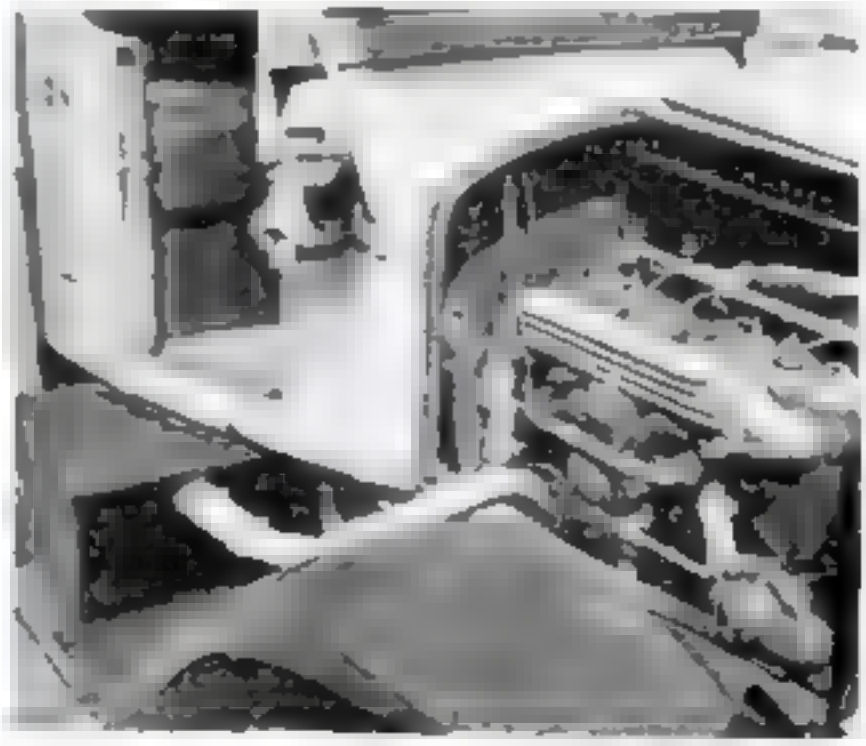


HARDWOOD chips are now driving the first solid-fuel trucks to appear on American highways. The standard gasoline motors of these trucks have been converted to the use of producer gas, a mixture composed of hydrogen, methane, carbon monoxide, carbon dioxide, and various tar gases. Pictured on this page is an experimental conversion made by the Rheingold Brewery of New York City, and believed to be among the first efforts in this country to adapt producer gas for use in commercial vehicles.

Under ordinary driving conditions, wood is added to the gas producer

Chunks of charcoal-like ash are removed from the generator daily through a cleanout door

Before it enters the motor, the gas is mixed with air by the perforated valve on the pipe



Beat the Gasoline Shortage?

Gas generated by wood chips is the fuel which powers this truck of the U. S. Forest Products Laboratory

every 50 to 60 miles. Hardwood, cut into chips less than 4" in length to prevent arching or pocketing in the generator, is used in preference to softwood such as pine because it leaves fewer tars and gummy residues. Even so, the cooling tanks and filters on the vehicle must be cleaned every 900 miles, and motor overhauls are in order every 5,000 to 8,000 miles.

Technical studies indicate that about 1.76 lb. of wood are required per horsepower hour. Gas producers fueled by coal or coke are more efficient, but they are much larger and more complicated. With wood, if no major changes are made in converting the engine, the maximum horsepower is about 70 percent of that on gasoline, provided that the spark is advanced and the fire is properly managed. But if the compression ratio of the motor is increased (producer gas knocks less readily than gasoline), horsepower can be pushed up to 85 or 90 percent of the gasoline rating. In general, tests show that substantially more gear-shifting is needed with producer gas.

When a cold start is to be made, wood is added from the top of the hopper and an electric fan is attached to the gas offtake pipe so as to suck a current of air through the producer. Ten minutes after the wood is lighted, the generator manufactures enough gas to run the truck. Starting the engine on gasoline will create sufficient suction to build up the fire, but this takes much longer.

As shown in the schematic drawing, the gas producer is a downdraft type. Air is supplied to the fire—within the conical walls of the refractory, or gas-generating area—by five air nozzles which run through the firebrick from the outer air jacket. The gas, produced by partial combustion of the fuel, flows out the offtake pipe to four cleaning and cooling tanks, fitted with baffles and connected in series. As it is cooled the gas becomes denser (under Boyle's Law) and hence more B.T.U.'s are supplied to the motor at each intake stroke.

A condensate trap is provided at the end of the fourth cooling tank to catch any moisture deposited by the gas, which next passes through a steel-wool filter and oil bath in a tank on the running board. Just before the gas pipe reaches the intake manifold, a valve admits air to the gas, at about a one-to-one ratio, and the mixture is then fed past the throttle to the motor.

During stand-by periods with the motor off, the stack valve at the top of the producer is opened, giving enough air to keep the fire going. This valve is also used to release excess gases at the end of the day. A dashboard control affords a means of varying the amount of air mixed with the gas as it enters the motor; the correct setting changes frequently with the behavior of the fire and the speed of the engine. In practice, the driver controls speed with the throttle and intermittently readjusts the air-gas mixture for best performance. Direct linkage of the two controls is not practicable.

Whether such vehicles, long familiar in Europe, will succeed in replacing conventional trucks in this country depends in large part on whether gasoline shortages become more acute. Certainly the indications are that reduced power and more frequent servicing lay heavy handicaps on producer gas in free competition with gasoline.

Gus Clears Up a

By MARTIN BUNN

GUS WILSON was bringing back the Model Garage wrecker a little before seven o'clock of a cool fall evening. Lighted dining rooms along the quiet suburban street reminded him that if he didn't hurry there wouldn't be anything left at the Park House for his dinner.

Just as he was pressing a little harder on the accelerator, a banshee shriek assailed his eardrums. "Whoo-o-whee-e-who-o-o!" moaned the siren in the courthouse tower down on Railroad Square. "Whoo-o-whee-e-who-o-o! Whoo-o-whee-e-who-o-o!"

"Three," Gus counted. "That's a fire."

He drove on. Down the street, lights flashed on in a garage that stood beside a white Colonial house; seconds later other lights went on in the garage of the cottage next door. Gus grinned. "Jim Allen and Fred Spratt," he thought. "Fighting each

other for the Buffs' Medal because the one who wins it will be the next chief of the Volunteer Fire Department." Headlights flared beside the white house; a car shot down the driveway and into the street. "There goes Jim," Gus told himself. "Always backs into his garage for a fast getaway if the siren blows . . . Fred'll be right on his tail."

He pulled in to the curb and stopped so as to give Fred Spratt a clear road. But no car came dashing out of the open garage. "That's funny," Gus thought. "I wonder—"

Suddenly a dark figure darted across the lawn and ran down the street. "That's Fred," Gus thought as he let in his clutch. He honked his horn as he pulled past the runner, a stout man in his shirt sleeves, already puffing hard. He swung aboard as Gus brought the wrecker to a stop. "Step on it, Gus! I gotta get to the firehouse before the engine pulls out!"

Gus stepped on it. Overhead wailed the siren. The sky at the end of the street had reddened to a sullen glow. "There's the fire," Gus said.

"Damn the fire!" Spratt snapped. "You've got to get me to the firehouse before the engine goes out. If you don't, Jim Allen'll win the Buffs' Medal. The dirty rat! Step on it, Gus'"

Once in Railroad Square, they could see the firehouse and a half dozen men running toward it. "What's the matter with your car?" Gus demanded.

"It wouldn't start," Spratt growled. "I dunno why, but I've got my suspicions." Gus kicked on his brakes by the firehouse just as the engine emerged with its siren yowling. Fred Spratt jumped off, landed running, and swung himself onto the engine. "I wanta see you after the fire!" he yelled back at Gus.

Gus told the Park House waitress he'd have a rare steak. He got a pitying look and a green pepper stuffed with assorted vegetable matter. Later, he drove back to the Model Garage to finish a job. He was washing up when the office telephone jangled.

"I'm glad I was able to catch you," Fred said over the wire. "The fire's just out—it was a tough one . . . You doing anything special, Gus?"

"Yes," Gus told him. "Something very special. I'm going home, and I'm going to bed. Call me the first thing in the morning."

"Now, Gus, you can't do that!" Spratt pleaded. "This is important—a real emergency call. Stop at *my* place on your way home, will you? My car's been tampered with, and I've reason to believe a certain party is responsible — the double-crossing rat! . . . Have I got proof? I've got enough to bring charges against him at tomorrow's meeting of the V. F. D. But I want to be fair, so before I do, I want an expert to go over my car and find out exactly what's been done to it."

GUS did some fast thinking. He isn't a member of the Volunteer Fire Department, but he has helped it over mechanical rough spots without taking a cent for his services because he realizes its value to the community. Its efficiency was bound to suffer if strife broke out between Spratt and Jim Allen. So he decided he'd try to straighten things out.

"O.K., Fred," he said. "I'll be over in fifteen minutes."

When he stopped his roadster in front of Spratt's garage the doors had been closed, but lights were burning inside. Spratt opened the side door to his knock.

The hood of the green sedan inside was raised. Spratt banged it down. "My car's just the same as it was when I tried to go to the fire," he said. "Now you try to start it."

"All right," Gus agreed. He got into the sedan and switched on the ignition. The starter ground over sluggishly, but the engine didn't take hold. Gus waited a half minute, then tried again. Finally he switched off the ignition

"Your starter isn't getting enough juice to crank the engine fast enough."

"Why not?" Spratt demanded.

"Offhand, I'd say your battery probably is run down. That may be your trouble."

Spratt grinned crookedly. "Yeah?" he scoffed. "Well, it isn't. I had it recharged only last week, and it didn't really need it. But don't take *my* word for it. Check it yourself."

Gus nodded and did so. The gravity reading for each cell was well over 1.250.

"Well?" Spratt demanded again

"Your battery seems all right," Gus said. "But hydrometer readings don't tell the whole story. The only way to be absolutely

Case of Sabotage

sure of a battery is to check it under operating conditions."

"All right," Spratt said. "Go ahead and check it your way."

"I've got a low-reading voltmeter here," Gus told him. "Switch on the ignition and keep your foot on the starter, will you?" As the starter ground feebly, Gus placed the voltmeter prods on the posts of each cell. The readings, with the battery discharging some 200 amperes, showed good voltage at each cell and very little difference between cells. "Turn her off!" Gus called.

"Was I right?" asked Spratt.

"You were," Gus admitted. "Your battery has plenty of juice, but a lot is being lost somewhere between it and the starter." He examined the terminals, cable, and ground strap. "Everything seems tight," he said, "but suppose you try turning her over again."

With the starter churning feebly, Gus put one voltmeter prod on the frame and one on the grounded battery terminal. The meter indicated a voltage drop of less than a tenth of a volt. "O.K. there, at least," he said. Quickly he put one prod on the starter-motor housing, leaving the other on the frame, and again the meter showed an insignificant drop. "There's a good ground connection between the starter and the mount," he remarked. Finally, he placed one prod on the starter-motor terminal and the other on the ungrounded battery terminal, then whistled as the meter hand swung over to two volts. "That's where the trouble is," he said. "In the starting-motor cable."

Fred Spratt let out a bellow. "Now let me tell you something!" he shouted. "You've found something wrong with that cable. Well, *that cable isn't the same one that was in my car this morning.* It was put in my car right in this garage this afternoon."

He went to his workbench and took a battery cable out of a drawer. "Here's the proof—this is the cable that *was* in my car. I found it in the trash box over there. And here's the worst of it. *My wife saw Jim Allen sneaking out of the garage this afternoon.* She was looking for our daughter Marge when she saw Allen close our garage door and walk away. I'm going to bring charges and I'll run him out of—"

"Wait a minute," Gus said. "Let's see where we stand before you start a war." He disconnected the starting-motor cable and compared it with the cable Spratt handed him. His face clouded. "It's hard for me to believe that it was Jim Allen," he said, "but it looks as if someone had done you dirt. This new cable is the same outside diameter as the old one, but instead of being No. 1 gauge it looks as though this were No. 4 gauge, which has only half as much copper, and so only half the current-carrying capacity of No. 1. Less copper means more resistance, so your starter couldn't get enough juice to spin the engine."

THERE was a rap on the door, and Jim Allen came in with a pair of tree-pruning clippers in his hand. "Hello, Gus," he greeted. "Trying to fix up Fred's old wreck? Fred, I saw your lights on and thought I'd bring back these clippers I borrowed this afternoon without asking — knew you wouldn't mind." He noticed the silence of the others then. "What's the matter? You look as if you'd caught me in your chicken coop in the dark of the moon!"

"Chicken stealing is honest," sputtered Fred Spratt, "compared to—ouch!"

Gus's heel had landed on his shin bone. "Here comes someone else," he said. A car had stopped in the driveway. The door opened and a girl came in, slim and smart in a WAC uniform. It took Gus a couple of seconds to recognize her as Fred's daughter Marge.

"Hello, pops," she said cheefully. "Hello, Mr. Allen. Hello, Mr. Wilson—don't you know me?"

"I didn't, for a moment," Gus said. "So you're in the Army now. That's fine."

Marge giggled. "I hope you keep on feeling that way," she said. "Because after the war I may ask you for a job. I'm a grease monkey, you know—just finished my automotive mechanics course."

"That's fine," Gus said. "How do you like getting all dirtied up around cars?"

"I *love* it!" Marge said. "Why, I can't keep away from it, even when I'm home. Pops didn't take his car out this afternoon, and I went all over it for him." She turned to her father. "You ought to be more careful about your wiring," she told him. "That starting-motor cable you had would never get by a motors sergeant. It was all frayed and its insulation was half worn away. I got a new cable downtown and put it on for you. Well, I'm going to turn in. Good night, everyone."

She went out. So did the conversation. Spratt looked at Allen, and his face turned from red to purple. Gus cleared his throat noisily. "Fine girl, Fred," he said. "You can't help admiring these modern kids."

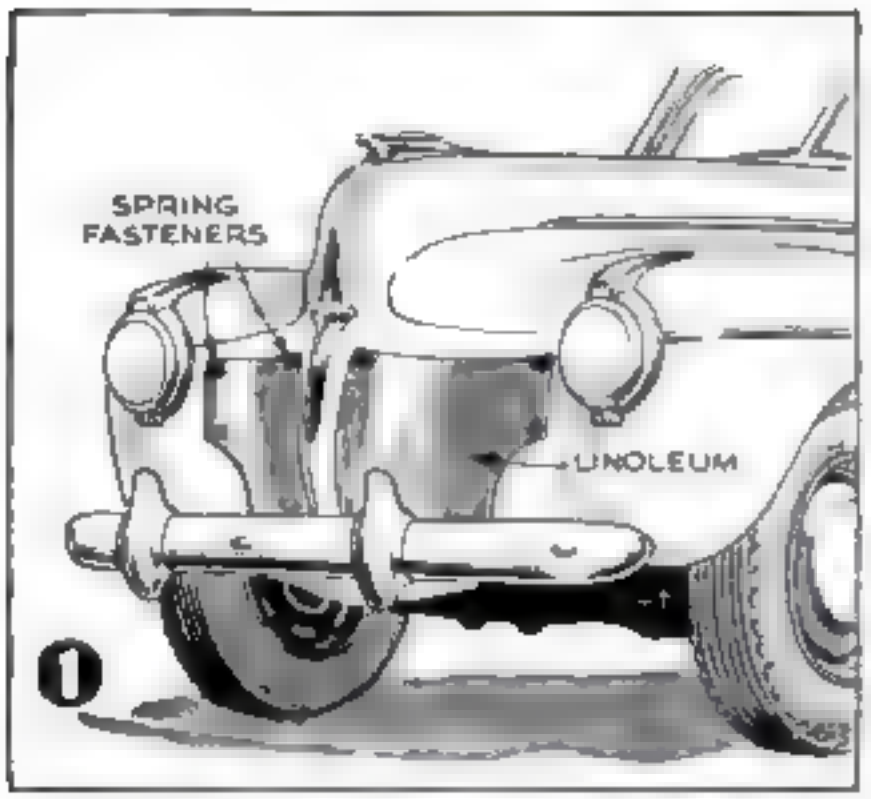
"She—she—she—" Spratt sputtered.

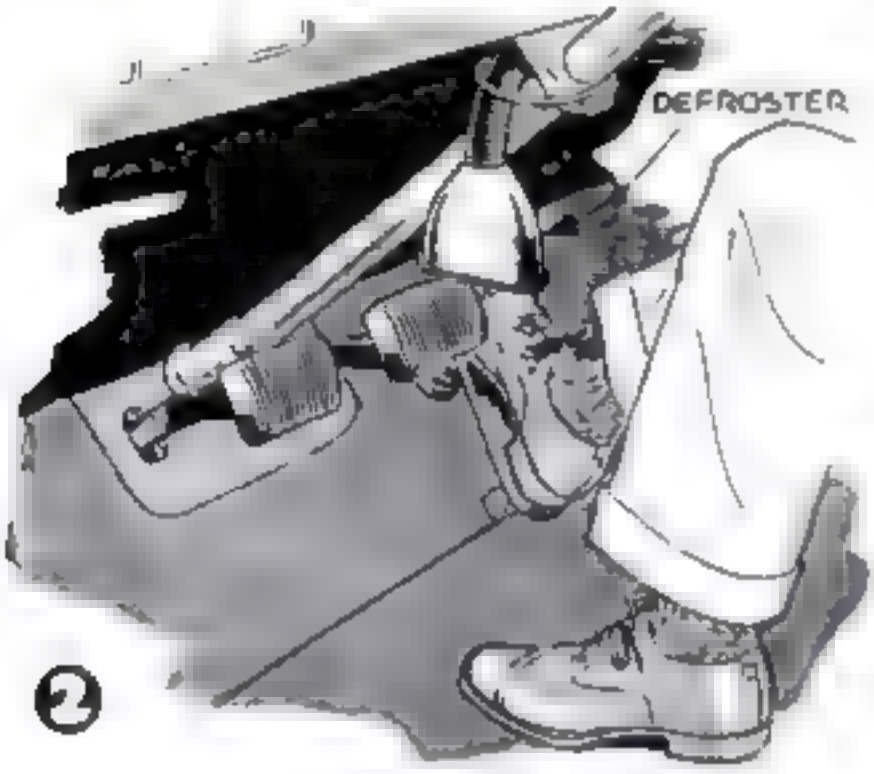
From outside came a banshee wail. "Whoo-o-whee-e-who-o-o! Whoo-o-whee-e-who-o-o! Whoo-o-whee-e-who-o-o!"

"Another fire!" Jim Allen yelled. "Come on, Fred—we'll go in my car." He started for the door, Spratt at his heels. "Want to come along, Gus?" Allen called back.

"Nope," Gus said. "I'm going home and go to bed. I've had too many emergency calls today, by gum!"

USEFUL AUTO HINTS





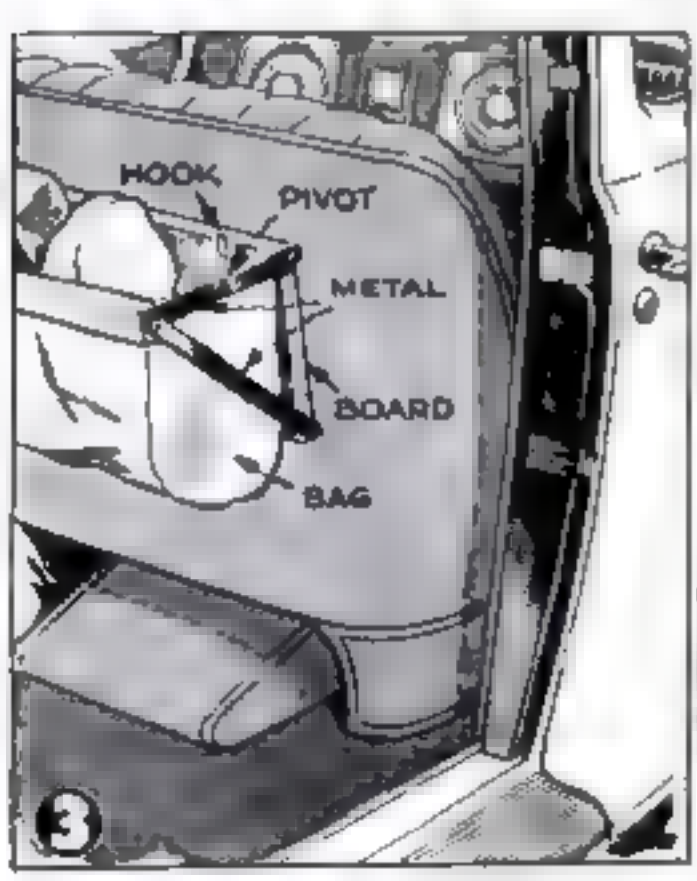
Drawings by William Patrick.

1 INEXPENSIVE WINTER FRONTS that will look well and give excellent service can be made from scrap pieces of linoleum. Cut the linoleum carefully to fit the radiator grill and attach it with regular spring fasteners after punching a hole in each of the corners. Finish with a coat of good-quality aluminum paint.—C. R. G.

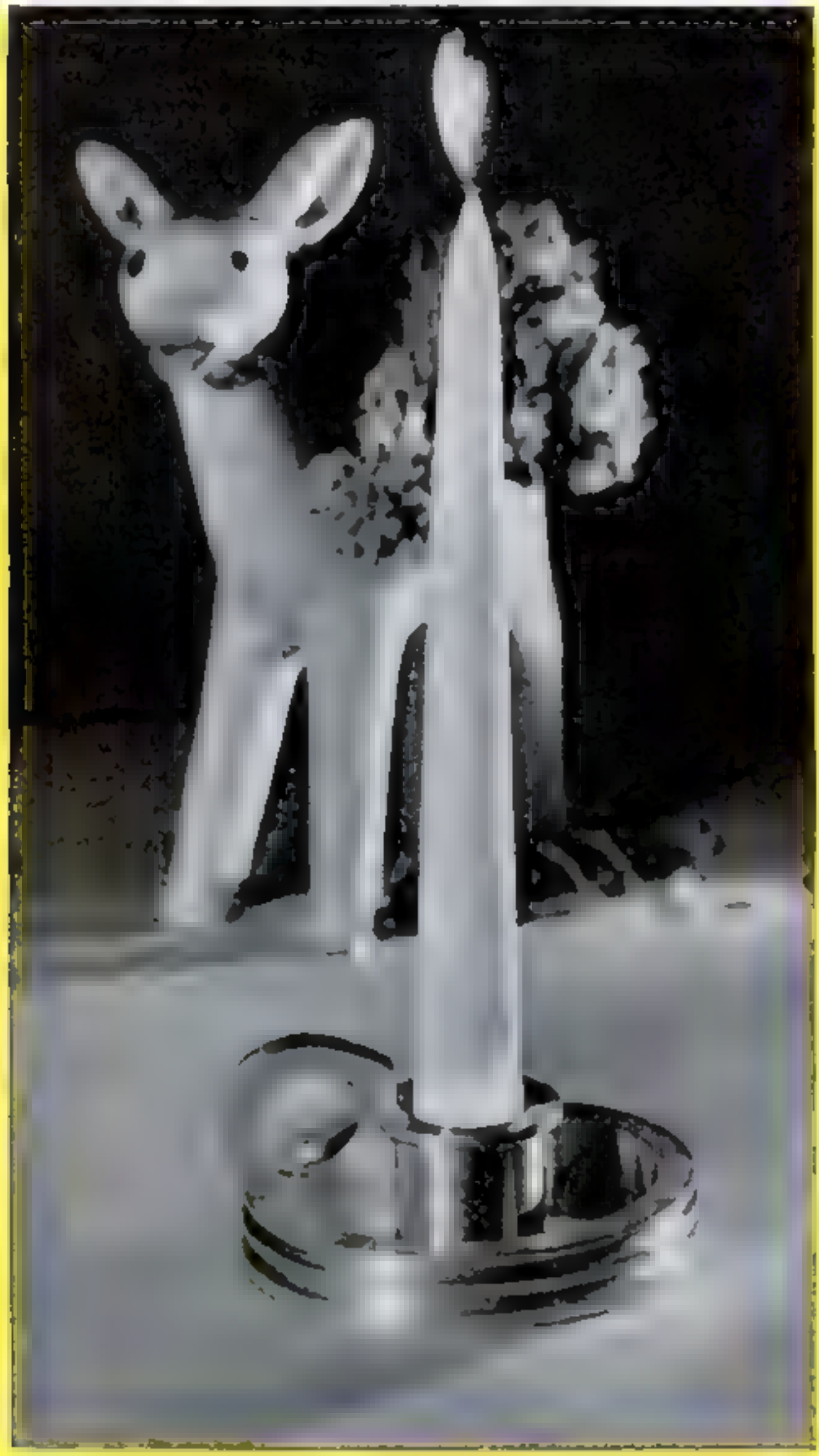
2 A DEFROSTER TUBE can be used to keep a driver's feet warm when the heater is remote from him, as heaters are in some cars. The device is sure to prove a great comfort in very cold weather, and only a few minutes are needed to install it. Secure one end of the tube to the heater and run it under the cowl to the steering post. Clamp the tube to the post, pointing it downward as shown at the left. This will provide a flow of warm air where it is needed.—C. B.

3 PACKAGE HOLDER. This will carry a lot of bundles and fold flat against the front seat when not in use. It requires a 36" long board, a similar length of ¾" by 1" stock, a piece of canvas, and some strap iron. Hung on two hooks screwed into the seat back, it is readily detachable. A small catch will hold it firmly in the folded position when it is empty.—M. G.

4 WASHING CARS is often made easier by a hose nozzle that will project a thin, flat stream of water. Such a nozzle can be fashioned out of a rubber tip like those used on the ends of crutches. Simply cut a slit with a knife across the closed end of the tip, and twist the open end onto the threaded coupling of the hose.—A. H. W.



HOME AND WORKSHOP



Lustrous metal by mellow candlelight . . . In the mood of the season, this candlestick makes an appropriate gift

Back the attack on tuberculosis by buying more Christmas seals

MODERN
Machined Candlestick

IS TURNED FROM OLD PISTON ON THE ENGINE LATHE

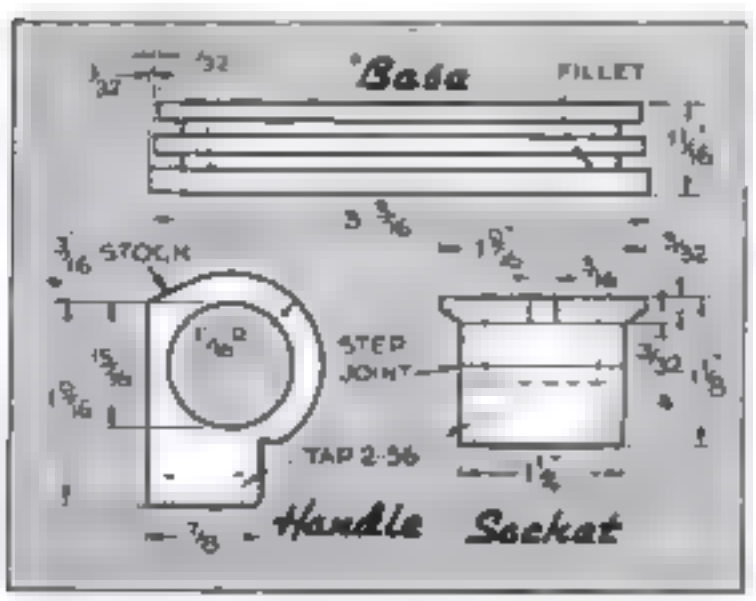
OLD-FASHIONED in concept, yet strikingly modern in design and execution, this candlestick proves that interesting craftwork projects can be made on the metal-turning lathe. A single aluminum-alloy piston provided most of the material.

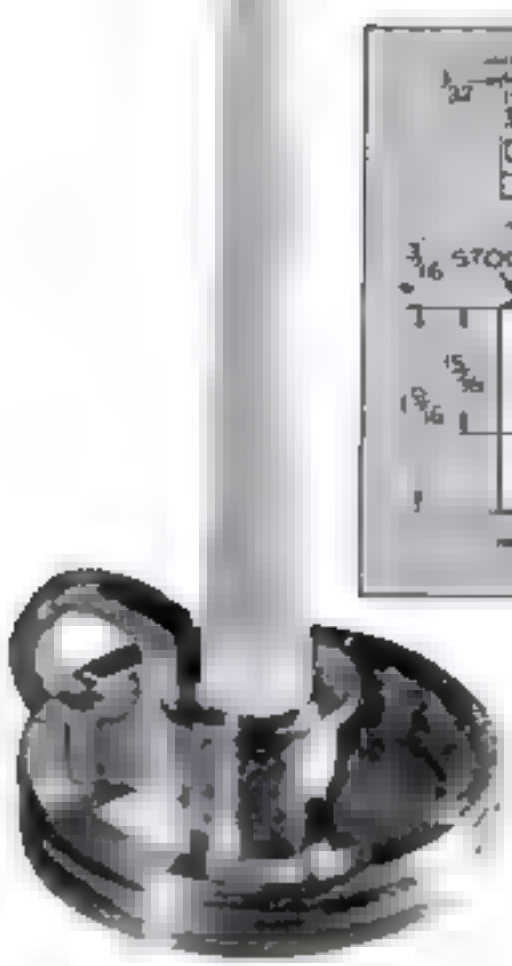
Clamp the piston in the three-jaw chuck and cut off the skirt with a parting tool as shown in Fig. 1. Turn out the head to a diameter of 3", leaving a fillet inside (Fig. 2). Polish with fine, well-worn emery cloth to a high luster.

Reverse the work on the expanding chuck jaws with a paper lining inside to avoid marring the turned portion. The ring grooves can then be turned bright as in Fig. 3 and cut back slightly for the step effect shown in the drawing. Take a finishing cut across the bottom with a facing tool.

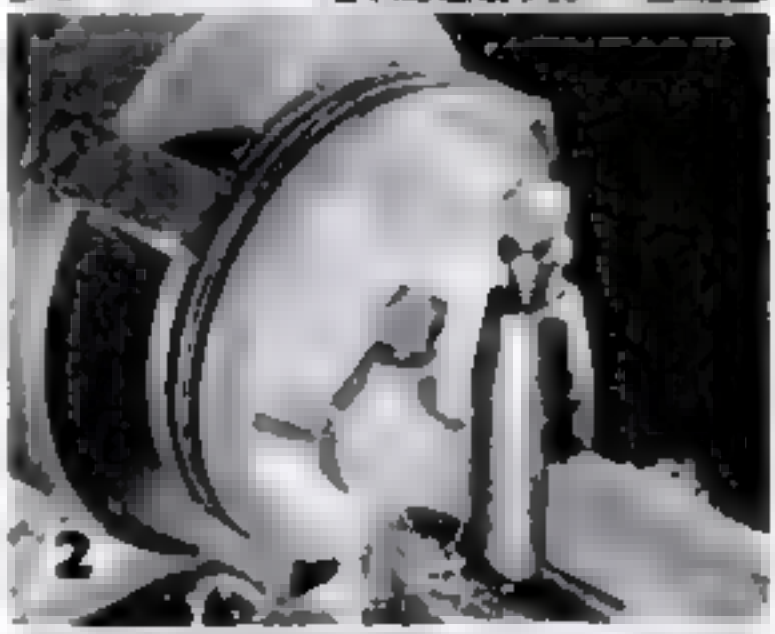
Saw the two piston-pin bearings out of the discarded skirt, chuck a short mandrel, and drive on one of the bearings (Fig. 4). Cut off the waste metal and turn the shoulder for the step joint. Turn the second bearing with a corresponding step to a force fit, press the two pieces together in a vise, and mount them again on the mandrel to turn the socket to the dimensions indicated.

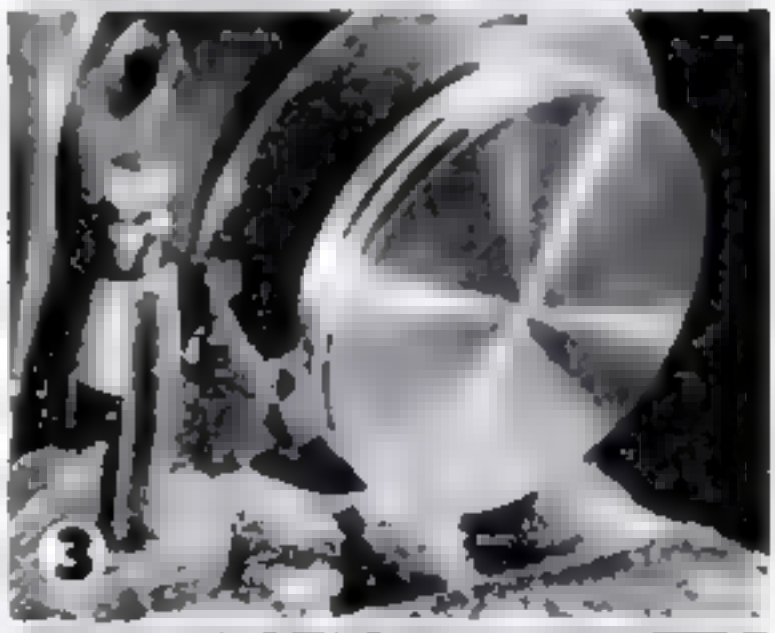
A scrap of 3/16" thick aluminum can be mounted in the four-jaw chuck for boring the handle hole. Jigsaw the outside contour to shape, using kerosene as a cutting fluid; then drill and tap the mounting holes and polish the piece. File a matching notch in the socket flange. Assemble the socket, handle, and base with 2-56 screws.—C. W. W.





Base and socket are turned from an old piston. Insert a bushing if a candle fits the socket too loosely





Don Quixote and the Windmill

A COMIC WEATHER VANE FOR JIGSAW ENTHUSIASTS

By HI SIBLEY

DON QUIXOTE astride his charger, Rosinante, is in luck this time, for he never quite catches up with this windmill, but he will make an interesting figure for your weather vane, especially when painted in bright colors. Both the mill tower and the horseman are jigsawed from ⅝" stock and assembled between sidebars of the same material.

The beveled vanes are constructed by mortising the two members at the hub, through which a hole is bored for the installation of a short length of tubing to act as a bearing. Oil-soaked cotton should be packed in this bearing as well as in the vertical axis of the vane, which should be corked against rain. After the windows and doors are cut, the roof and sides of the mill are painted to represent shingles, while stonework is simulated at the base. The horse may be white, and the rider varicolored.

Place-Card Favor Features Tiny Skier

A NUMBER of these engaging little place-card figures can be made from a pair of shoelaces and a package of pipe cleaners. Clothe the figure in ski pants by slipping pipe cleaners through short lengths of shoelace and bending the ends to resemble feet. A wooden bead makes the head; colored yarn the bodice. The base is a bit of cardboard.—B. N.

Novel Jardiniere and Hurricane Lamps

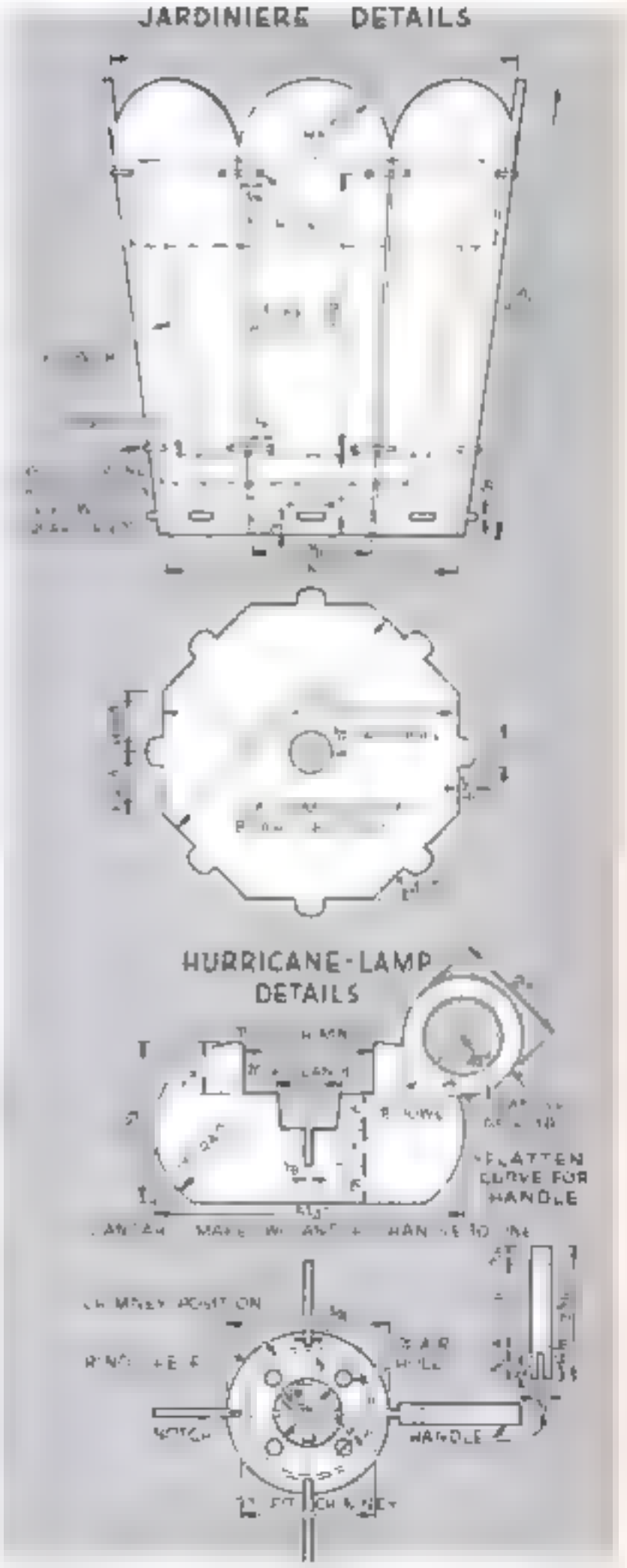
MADE FROM SCRAPS OF COMPOSITION BOARD

Designed by Ernest R. Dewalt

THESE two composition-board projects will yield pleasure in the making as well as decorative objects of real utility in the home. The flowerpot holder is composed principally of eight tapered segments, or slats, which are laced together to form slanting sides. Thus the sides are fitted securely around an octagonal base, forming a jardiniere that nicely accommodates and conceals a clay pot and dish. A pair of hurricane lamps set on bases of crossed composition board will keep their candles alight in a brisk breeze, when used to shed pleasant, mellow light out of doors.

For the jardiniere, cut all the slats at the same time from ⅛" stock, suiting their dimensions to the size of the pot and dish. To determine the taper of the slats, draw a circle the diameter of the rim of the pot, and another the diameter of the clay dish, and circumscribe an octagon about both circles. Measure a side of each octagon to obtain the top and bottom width of the slats. Drill holes for the lacing as indicated in the drawing, and also rout slots ¼" up from the base of each slat to receive the tenon tabs of the base. Make the sides of the base equal to the width of the slats at the line of the slots, and fit the tenons into the slots snugly. Finish the jardiniere with three coats of varnish.

The stands for the hurricane lamps are designed to hold 5⅝" chimneys with 2¼" bases. Cut the four standards at the same time. Lay out the chimney notches, the tapered shoulders to hold the candles, and the deep half-lap slots. Center all cuts and use a 1½" radius to round the ends. The wood handles should be slotted and joined to the standards with dowels. Notches are made in the center rings where they fit over the chimney notches. No glue is needed when the stands and rings are assembled.



ORNAMENTS SERVE AS MODELS FOR Novel

By ELMA WALTNER

CANDLES are so traditionally a part of the holiday season that even in their plainest form they rival holly and mistletoe as symbols of Christmastide. Gay candles like those above, however, will lend an added air of festivity to any surroundings, and they can easily be made at home in many different and fanciful shapes.

You will need some inexpensive glass or china figures such as are stocked on the knickknack shelves of variety stores. By using these figures as patterns, you can cast various different candle molds. Any type of figure will do so long as it is nonporous and has neither undercut surfaces nor frail parts extending too far out from the main mass. The molds are made by pouring ordinary plaster of Paris around the patterns.

With a figure at hand, obtain a light cardboard box that will accommodate it with at least ½" to spare all around. Work a small lump of modeling clay into the shape of a cork and stick it against the bottom of the figure as shown in the drawings. Oil the figure evenly with light machine or olive oil. Mix a supply of plaster to a creamy consistency. With one hand, hold the figure about ½" above the bottom of the box; then add plaster until the model is half immersed in it. Keep holding the figure for a few moments until the plaster is stiff enough to keep it from sinking. In 15 minutes, use a knife, drill, or countersink to form the two keys which will later aid in locating the other half mold properly.

Now thoroughly oil the top surface of the half mold to permit separating of the two parts easily after the top half has hardened; then completely cover the figure with more plaster. Allow another 15 minutes for this new "pour" to set. Peel away the paper box and use the blade of a knife to pry the mold apart. It will separate easily

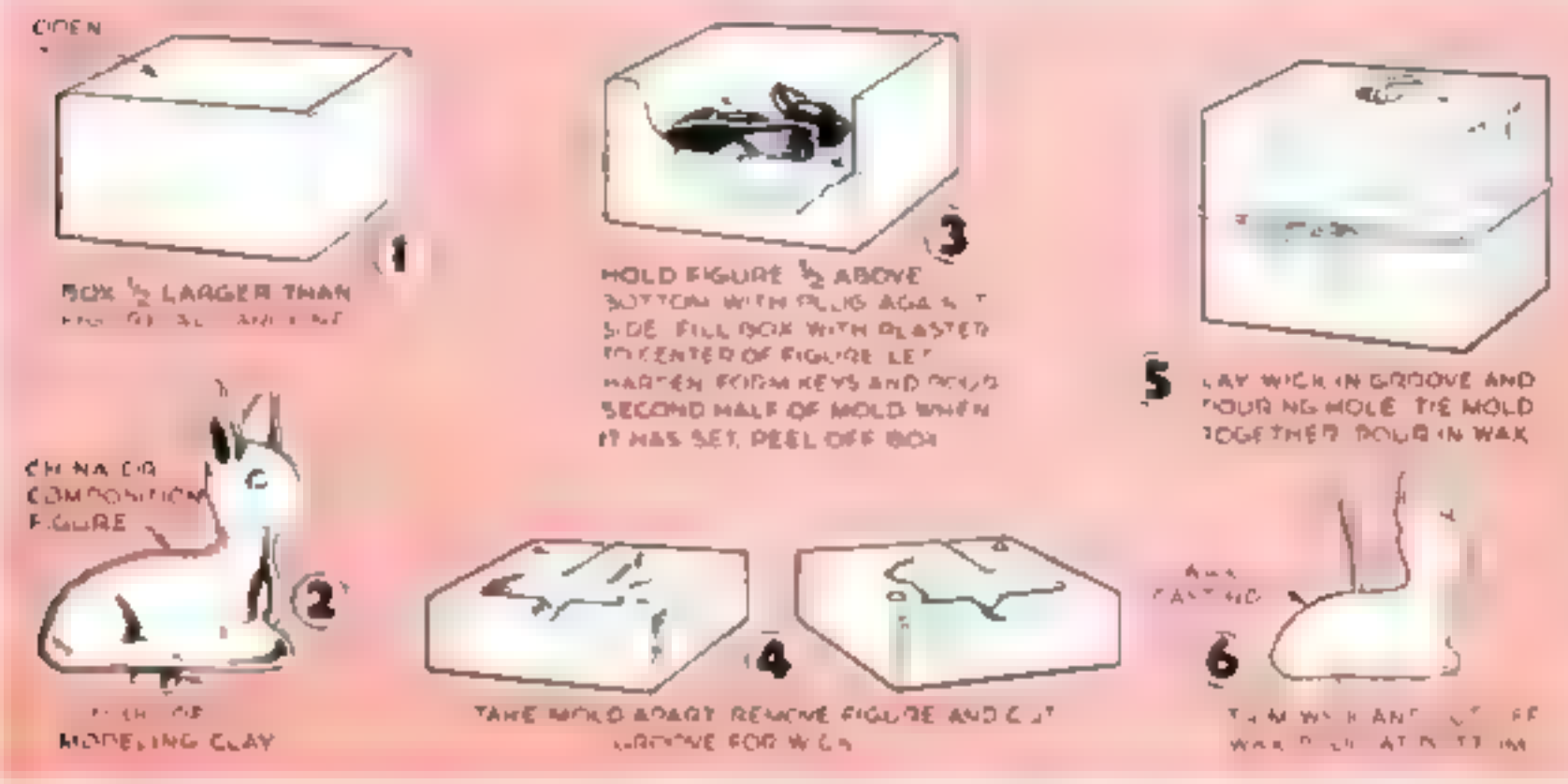
Melt the wax of some inexpensive colored candles and remove the wicks. Heat the wax over hot water rather than directly over a flame, for overly hot wax will create bubbles in the finished candle. At the top of one of the halves of the mold, cut a little groove through which the wick may extend. Then lay in the wick from the top of the mold to the bottom, where it should be long enough to extend through the pouring hole formed in the plaster as it hardened around the lump of clay. Join the two halves of the mold and bind them securely together with

Holiday Candles

stout cord. Turn the mold upside down and pour in the melted wax, which should first be allowed to cool to a point where it will harden immediately upon contact.

The wax will shrink a little as it cools in the mold, and you may need to add a little after the first complete filling. Allow the wax to set, but not to become completely cold. Then untie the mold and remove the candle. If the first candle has a tendency to stick, grease the inside of the mold before pouring the next one.

Figures modeled in clay, as well as glass and china figures, can be used as patterns for candle molds. Amateur modelers can produce many appealing original pieces.



Star-Shaped Santa and Pine-Cone Bird Help Decorate Tree

SANTA CLAUS, in the genial guise of a Christmas-tree ornament, appears in the photograph below in a really stellar role. A number of these fat little star figures, dangling from the boughs of a yuletide evergreen, will be more distinctive than most machine-made tree baubles; and they can be turned out in jigtime with little more than a pair of scissors and a few household materials. Cut the star from a piece of red construction paper and paste a small strip of white paper on part of one point to serve as the face. Ink in the eyes and nose; then add the fur trim, buttons, belt, and the old gentleman's whiskers, using wisps of cotton attached with glue. Slip a wire or loop of colored string through the tip of the uppermost point of the star.

The cocky little bird of paradise at the right will also grace a festooned spruce or hemlock. Shape the head from a small pine block and attach it to the pine-cone body with a dowel glued into holes drilled in each part. For plumage, use either real feathers or swirls of bright-colored paper glued to the cone. Suspend the bird from a ring of wire covered with crepe paper. A painted wooden ring, if you have one handy, will serve as well for a perch.

Musical Christmas-Tree Stand

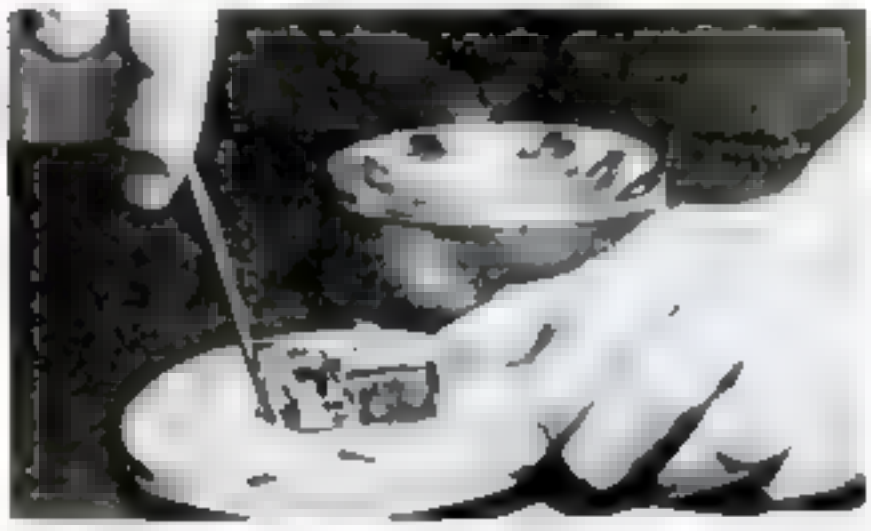
FITTED with a "musical motor" from an old powder box, a wooden candy bucket can be easily converted into a permanent Christmas-tree stand. Almost any music box will do, for the tinkling little tune is appropriate for Christmas. Your candy store will usually have some empty buckets made of white cedar, which has good resonance.

In use the bucket is inverted, its base serving as holder for the stem of a small tree. Strengthen the base by attaching inside a 4" block of two by four. This reinforcing piece is held in pace by $2\frac{1}{2}$" flathead wood screws which are countersunk in the top of the stand. Bore a hole through the top and the block together, using an expansive bit set to about 1". To secure a wedging effect on the tree stem, taper the hole with a rasp. If the tree proves too small for a snug fit, it can be held firmly with several pine wedges.

Attach the motor to the inside of the bucket after boring a hole for the winding key. Then replace the bucket top for extra strength. A hinged door makes the stand useful for storing tree ornaments between seasons. If labeled "Secrets," the door gains added fascination for children.

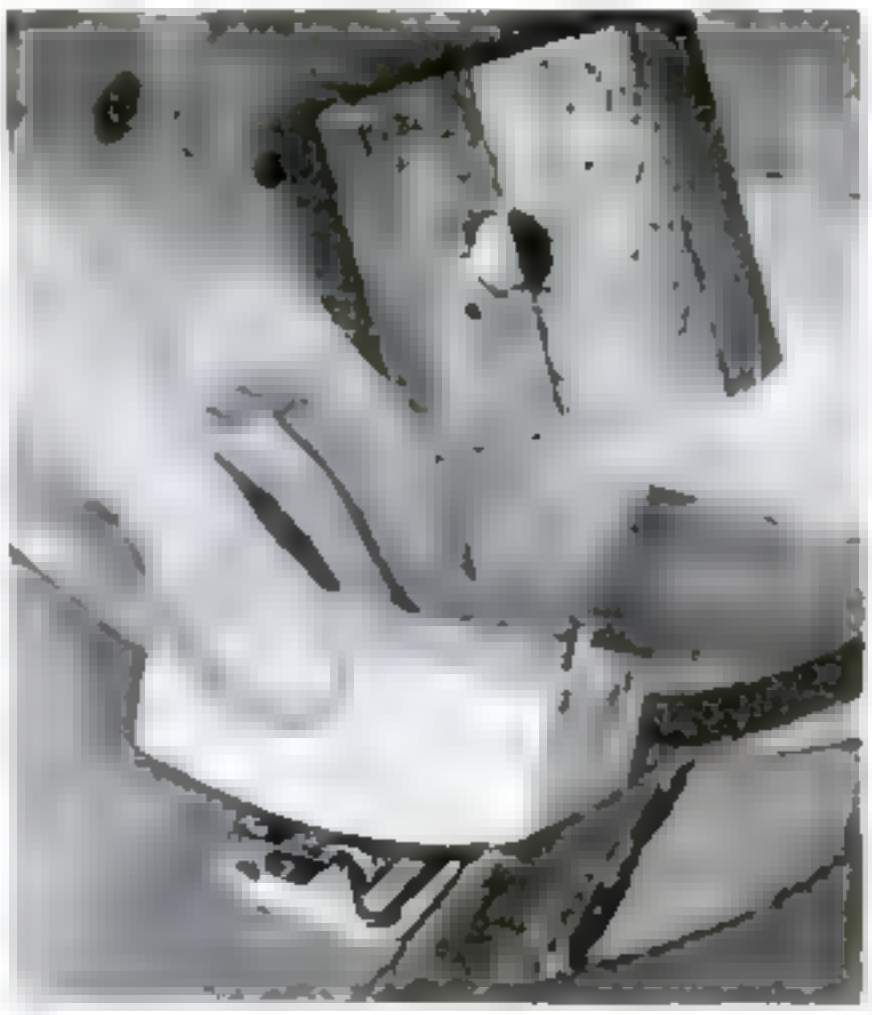
Outline designs on the unfinished wood with a burning tool, and paint with gay colors, or use stencils or decalcomanias. Finish by applying two coats of varnish to the entire bucket. RICHARD F. TRUMP.

Music coming from his tree will charm any child



Take the "musical motor" from an old powder box

Install it in the base and cover it for protection



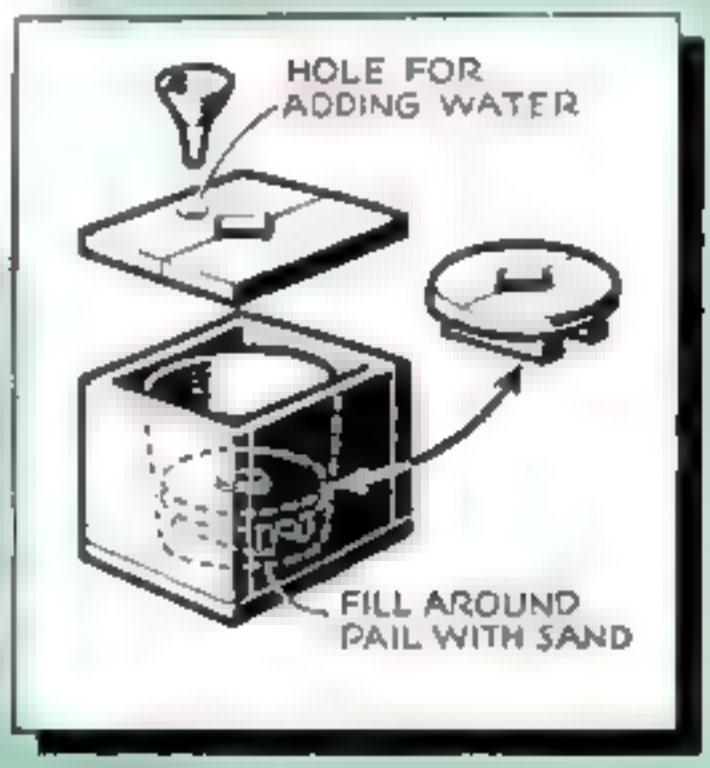
GUARDING YOUR HOLIDAY TREE AGAINST *FIRE*

WATERING your Christmas tree, just as you watered your Victory garden last summer and water your potted plants and cut flowers now, will keep it fresh and alive through the Yule season and will prevent discoloration and falling of needles. More important still, watering helps to reduce the ever-present fire hazard.

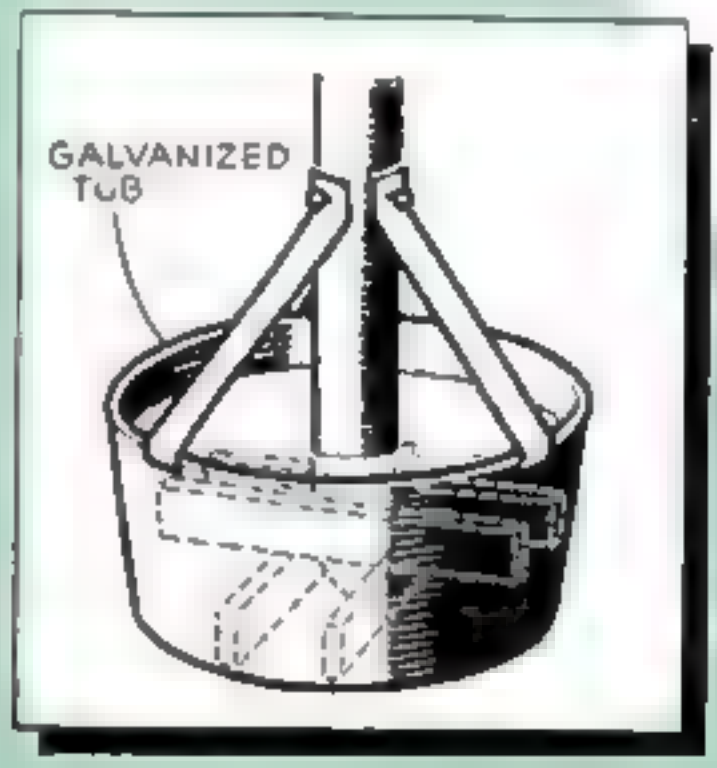
The U. S. Department of Agriculture's Forest Products Laboratory at Madison, Wis., in co-operation with the University of Wisconsin, has investigated various treatments and recommends standing your tree in water as simple and satisfactory. It advises cutting off the end of the trunk diagonally at least 1" above the original cut and keeping the water level above this newly cut surface while the tree is in use

Four types of stands containing water receptacles are shown in the drawings below. All can be made in the home workshop. The size of the container is optional but add water as the supply is absorbed

Although a tree treated with water will resist an ordinary candle or match flame, it cannot withstand intense heat, and additional precautions are necessary. *Don't* use defective electrical connections; *don't* overload a circuit and risk a short, *don't* neglect to replace a broken bulb, since the socket may touch metal foil and short; *don't* put large amounts of combustible decorations on or near the tree; *don't* stand the tree near an open fireplace or portable heater, *don't* place the tree where its accidental burning might ignite curtains, and above all, *don't* place it in a doorway where it might trap occupants of a room

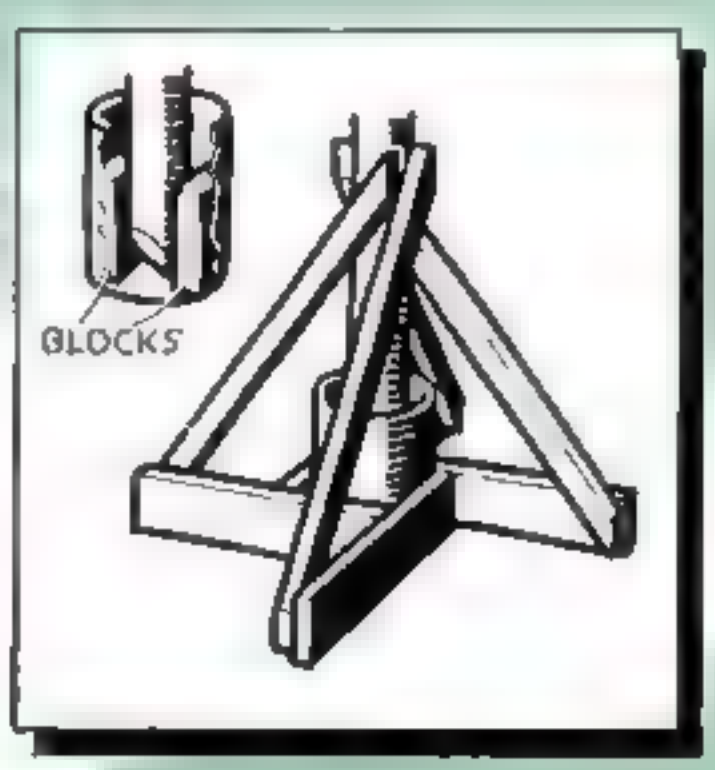


A stand made of a wooden box and a pail

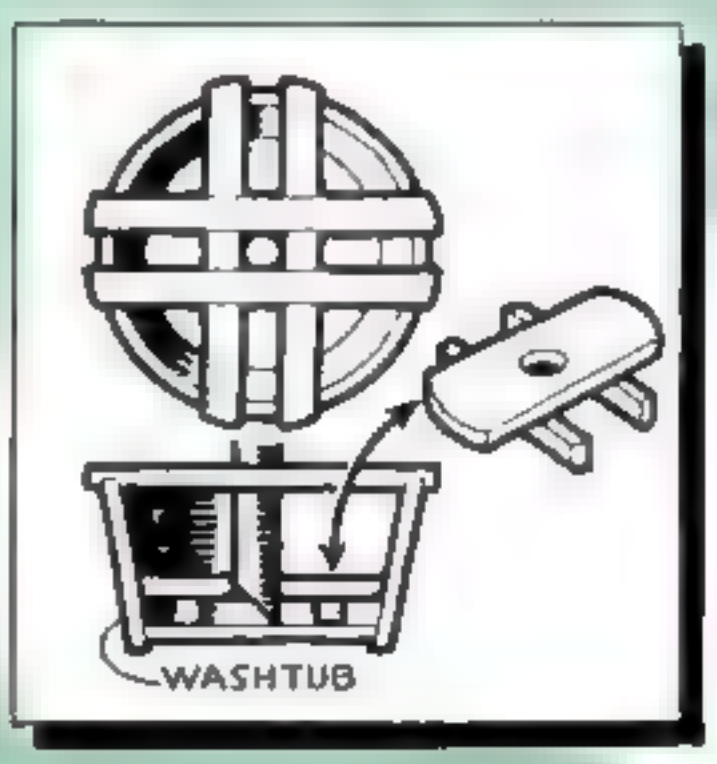


A galvanized tub with strap-iron braces

Cross-braced feet hold the tree upright



This container is built from a washtub



OCCASIONAL

By

Charles and Bertram Brownold

THIS curved-front cabinet, with handsome reeded doors, embodies many qualities that will appeal to the amateur craftsman and is so easy to make that only simple tools and elementary ability are needed for its construction. Its adaptability to a variety of purposes will make it as useful as it is ornamental. When hung low on a wall, it will serve both as a very handy recess for odds and ends and also as a console table; raised higher, it becomes an excellent china cabinet; and it will take the place of a capacious night table when fastened to a wall near the head of a bed.

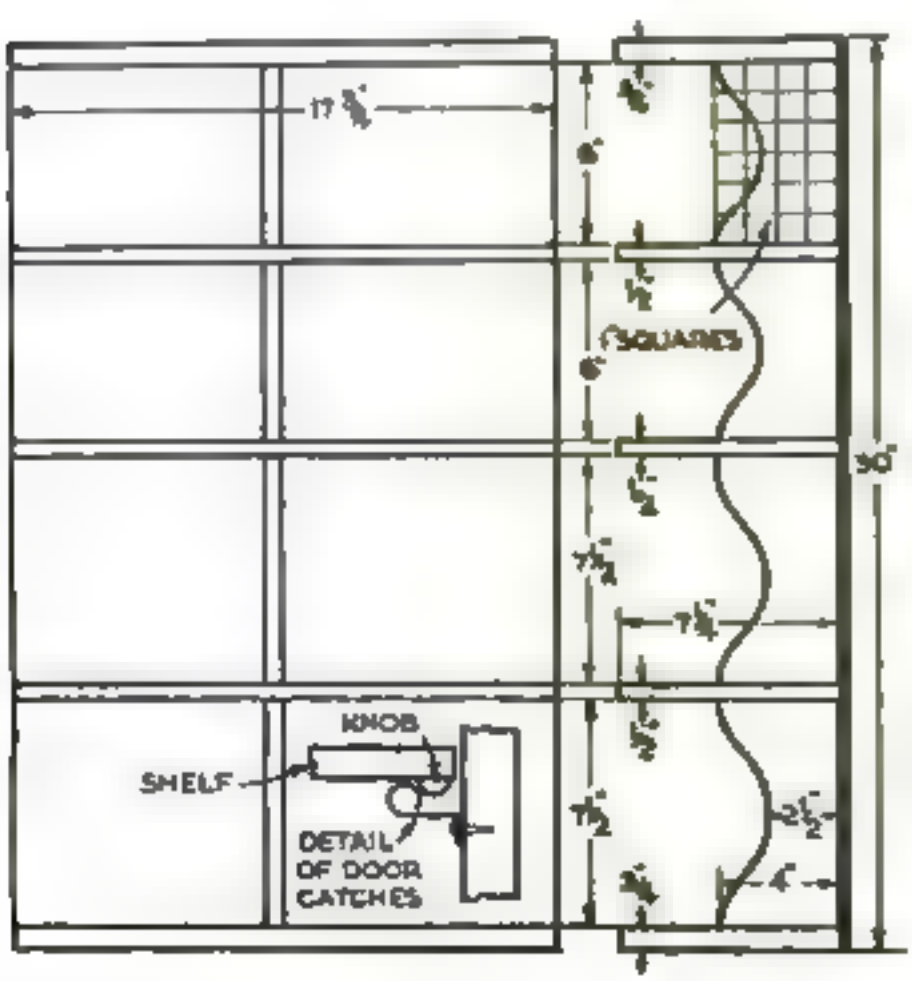
When closed, the cabinet is one half of a hollow cylinder bisected vertically. The shelves are semicircular, and the doors are constructed by screwing pieces of half-round molding to curved cleats.

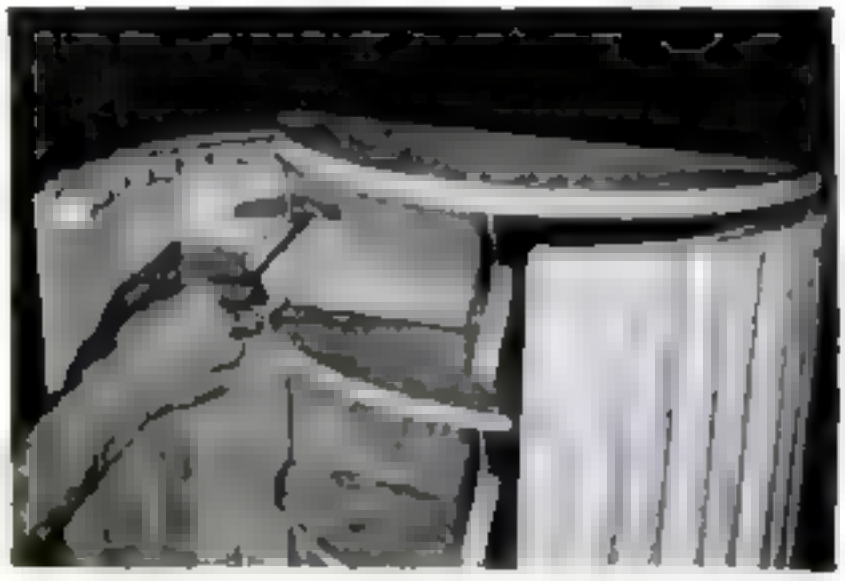
Lumber yards carry 1⅜" half-round molding as a stock size, and it can usually be had in oak and pine, and often in other woods. When attaching the molding to the curved cleats, test the straightness of each piece before screwing it into position. Hold it against a straightedge and, if light shows through, trim the edges with a plane or with sandpaper. This is a necessary precaution, because some of the pieces of molding will be found to be slightly bent, and a good job requires that they be fitted next to each other tightly with no cracks showing between.

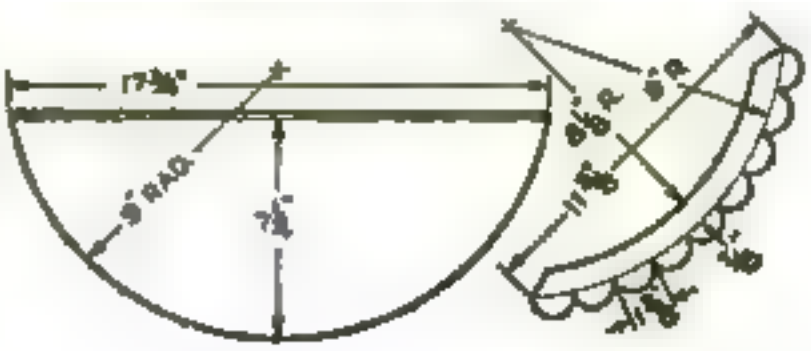
When marking the wood for cutting the curved cleats, as indicated in one of the drawings, it is useful to know that an 11⅝" chord on a circle having a diameter of 18" will subtend an arc that accommodates nine pieces of 1⅜" half-round molding. Each door of the cabinet includes nine such pieces.

The curved cleats can be made from any kind of scrap wood, those in this cabinet having been cut from scraps of ⅜" five-ply fir panel. Any kind of hardwood will do as well. However, if a softwood such as pine is selected for the purpose, each cleat should be made of two pieces glued together end to end with a splined or a scarf joint.

The hinges used to attach the doors to





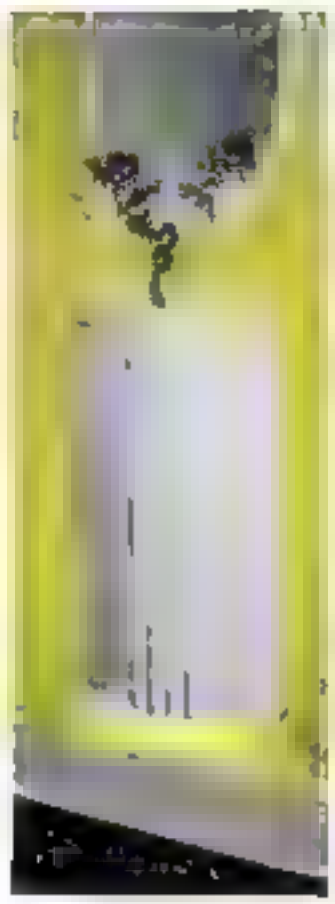


CABINET WITH REEDED DOORS

the back of the cabinet should be sufficiently long for each hinge to be screwed to at least two pieces of the molding, as indicated in a photo on the facing page. The screws should also be located so that they pierce the thickest part of the molding, and this may necessitate the drilling of special holes in the hinges.

As the door hinges cannot be seen from the outside when the cabinet is closed, the lines of the completed piece are not broken by them, nor by any knobs, door pulls, handles, catches, or other hardware. The doors are held tightly closed by two spring catches, one of which is fitted to the inside of each door in such a position that it engages a small, curved block of wood screwed to the underside of one of the shelves. Each catch is made of a scrap piece of flat spring metal, about ⅝" wide, and is bent so that a longitudinal cross section of it describes a figure 6. The doors are pulled open by means of a depression or finger grip ¼" deep cut into the lower ends of the two pieces of molding that meet when the doors are closed.

Sometimes a larger cabinet will fill a particular need better than this medium-sized one. If so, a builder will find it easy to alter the accompanying measurements to suit his purpose. It is also possible to construct a circular table out of two such cabinets fitted with legs and bolted back to back.

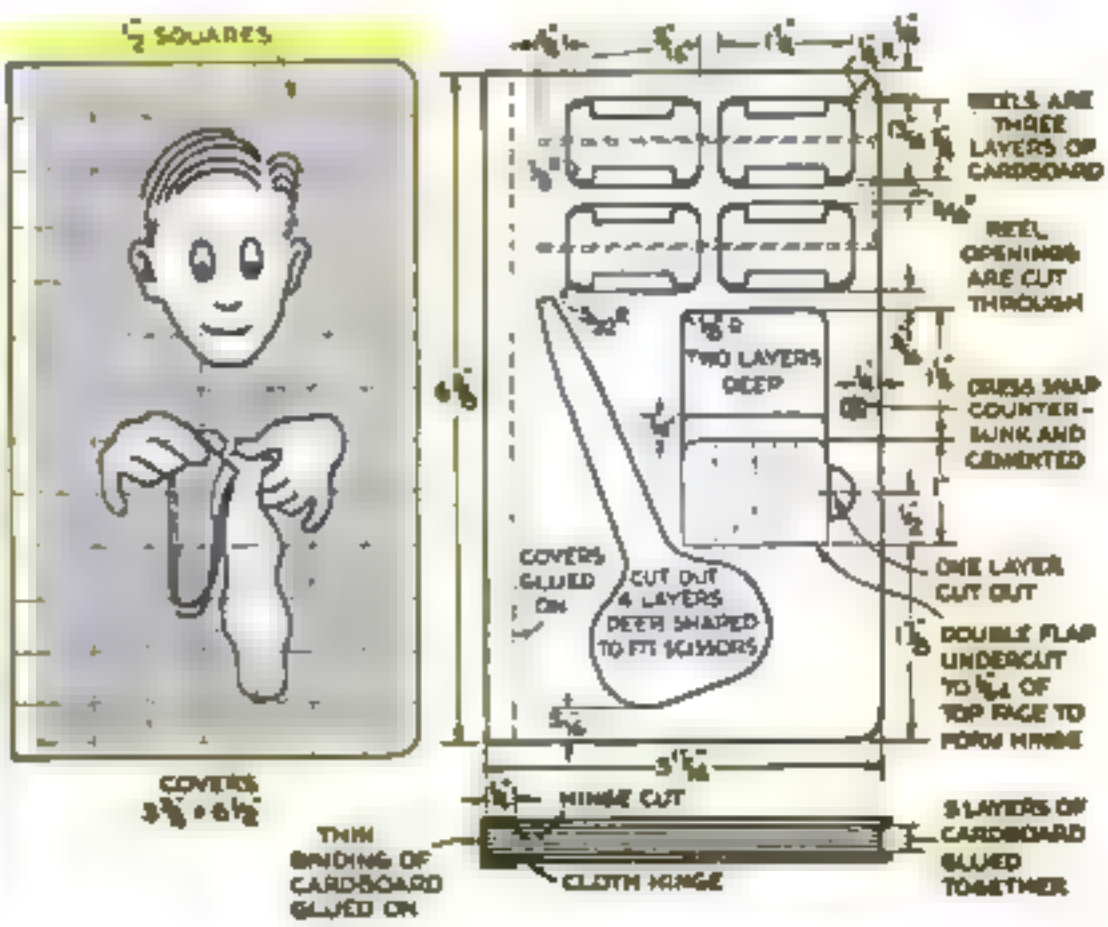


Hand-Tooled Design Decorates Compact Cardboard Sewing Kit

COMPACT, neat, and highly useful to men who are serving in the armed forces, this sewing kit contains a pair of scissors, four reels of thread, and a compartment for needles. The body is built up of five layers of 14-ply show-card stock cut out to provide recesses for the scissors, thread, and needles, as shown in the drawing, and then glued together.

Covers are made of one layer each of the same type of cardboard glued to the back edges of the body and bound there with tape. The four reels for the thread are made of three layers of cardboard, with the center layers cut to form a slot for wire axles that can be removed from the body to free the reels for rewinding.

All the surfaces of the kit are finished with two coats of colored varnish and a coat of liquid wax. The caricature of a man darning a sock is drawn on paper and then traced on the cover with a tooling instrument. A hand-tooled mottled design further embellishes the covers.—FRANK SHORE.



PROSAIC CHEESE BOXES FORM

Custom-Built

THAT MAKE WELCOME

By HERBERT BAST

HASSOCKS and footstools are much in demand in a home where a fireplace is the center of attraction on winter evenings, and they are also useful in other rooms. Attractive ones like those shown in the photographs can be made from a round cheesebox with the addition of padding and a yard or so of upholstery material. Though you won't have the ration points to order a whole cheese, your grocer probably will be glad to give you an empty box for the asking or at a small charge. These boxes are standard, measuring 14" in height and 15" in diameter

Clean the box thoroughly inside and out, using a solution of trisodium phosphate or very hot soapy water; then, after it has dried, set it in the sun to remove any remaining trace of smell. Examine the box next to determine what reinforcing will be needed to make it a safe seat. Three equally spaced 1" by 2" or similar uprights should add sufficient strength. If the bottom is not substantial enough for taking tacks, replace it with a ¾" thick disk, as in Fig. 1.

Two types of welts are shown on the finished hassocks on this page. For the so-called side welt at the bottom left, extra padding is required on the top. Cut a piece of burlap or muslin 24" in diameter and center it on the box top as in Fig. 2; then tack it to the top all the way around a circle 2½" inside the rim. Place a few layers of cotton felt or stuffing around the rim under the burlap and draw the cloth tightly

This pleated summer slip cover may be fitted over the padded top of the hassock just below

The top piece of this hassock is tacked in place before the welted side fabric is likewise applied

Both top and side coverings for this hassock are sewed together before being drawn over the frame

THE FRAMEWORK FOR

Hassocks

CHRISTMAS GIFTS

over it, tacking the edge to the sides of the box about 1" down from the top, as in Fig. 3. Distribute stuffing evenly on the top and secure it with a layer of cotton felt. Cut a piece 22" in diameter from the upholstery material for the top cover and stretch it down over the stuffing, tacking it to the side underneath the padded edge.

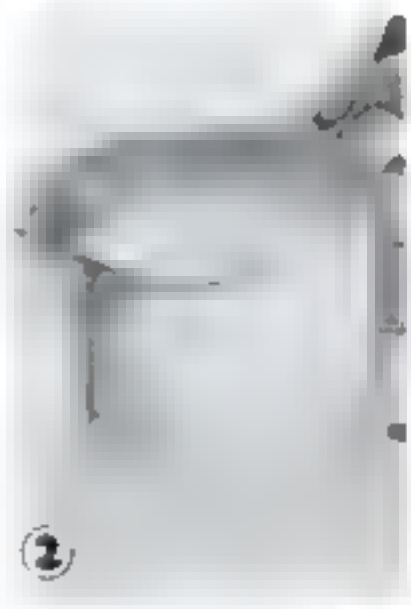
For the side upholstery, use a piece the width of the material—50" or 54"—and 14" in length, and to it sew a 1¼" welt made from the same or contrasting material folded and sewed around a cord. Then tack or sew the side piece at the top (Fig. 4), putting it high enough to cover the tacks used in upholstering the top, and tack one or two layers of cotton felt to the sides of the box. One layer is sufficient if the upholstery material is 50" wide, and two are better if the width is 54".

Work the side cover down carefully, as in Fig. 5, to keep it from wrinkling, and tack the edge evenly to the bottom. Start tacking from the center of the material and work alternately a short distance each way toward the open ends, which are sewed together with an upholstery needle (Fig. 6) when the tacking has been completed. To finish, turn the edges of a circular piece of black cloth and tack it to the bottom.

The hassock with the pleated skirt has the same built-up top and side welt and should be attractive in an early American room or a bedroom. Extra material is needed for the pleats, but side padding is unnecessary. Cut the skirt 16" by 108", hem the bottom the full length, and fold the top into box pleats, pinning each pleat 2½" wide with a 1¼" space between pleats. Sew the welt over the pleats and tack or sew the skirt all around the top edge. If desired, this piece may be made as a slip cover for use over the side-welt upholstered stool.

To upholster with a top welt, as shown in the photo at the bottom of the facing page, make a 1½" wide welt and sew it to a 22" diameter top cover, leaving the ends open. Cut fabric for the sides 14" by 50" or 54", and fit and sew this to the welt and the circular top. Pad the box with three layers of cotton felt on the top and one or two layers on the sides; then fit the cover over it, pulling it down carefully, and sew up the open edges.


1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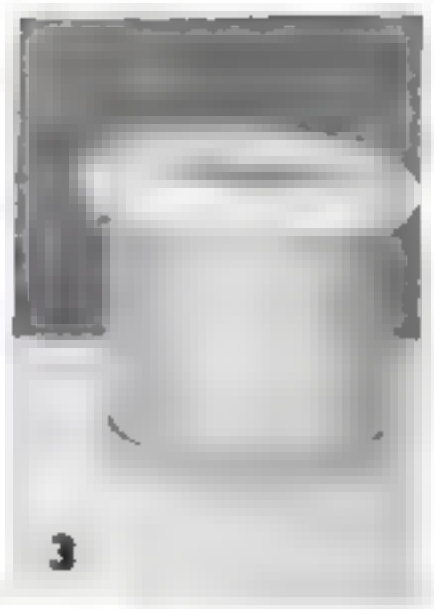
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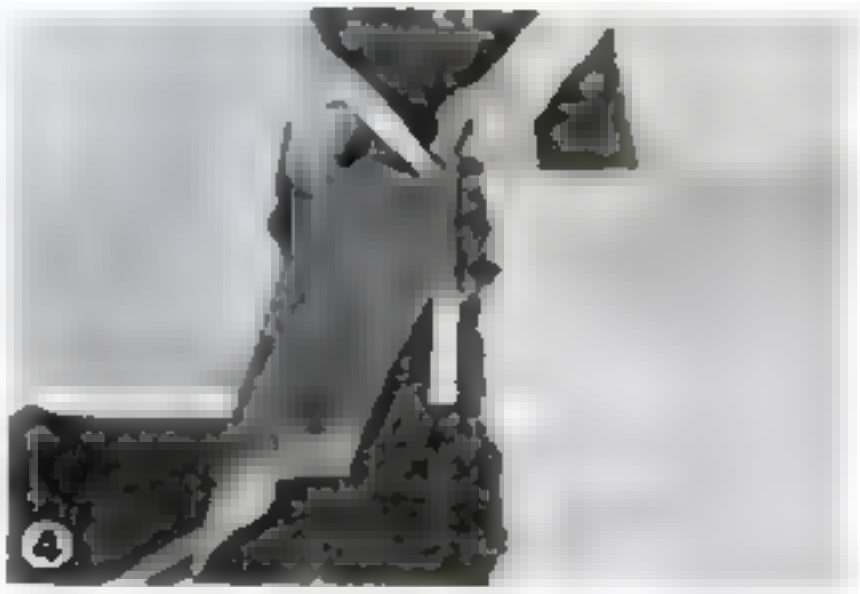
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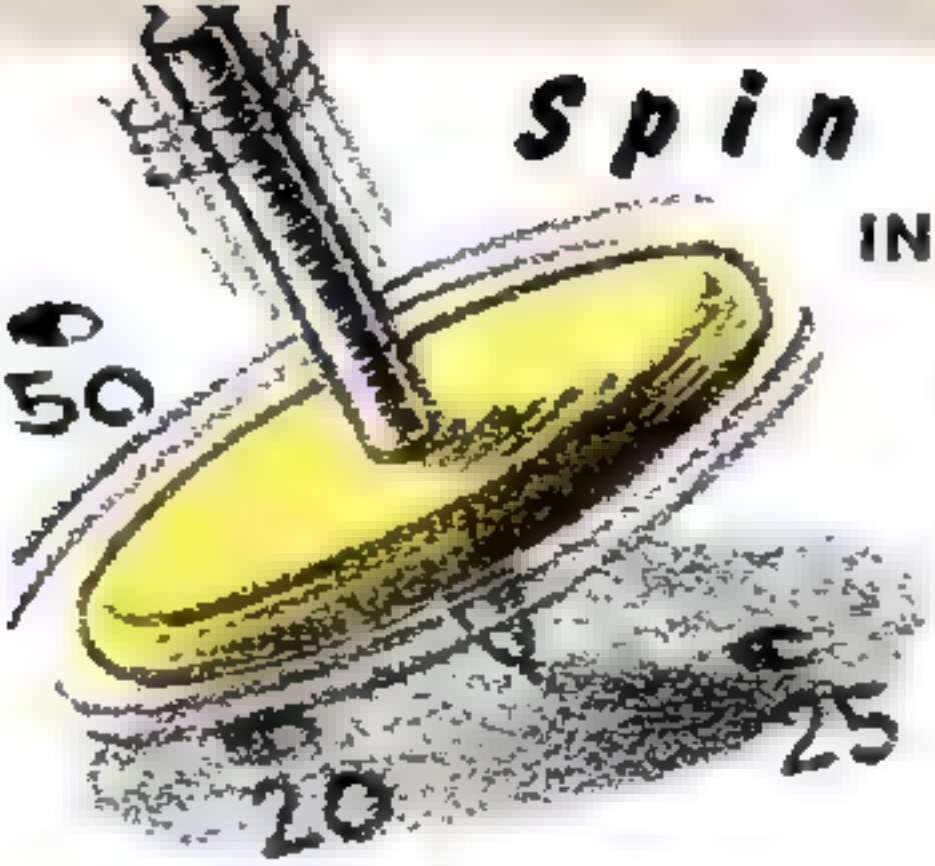
6

Spin to Win . . .

IN THIS EXCITING TOP GAME

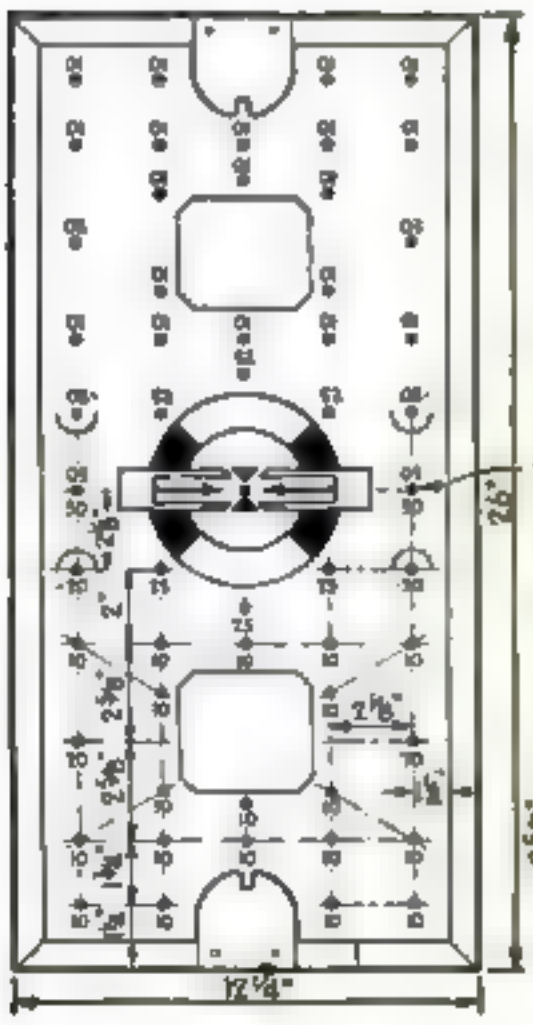


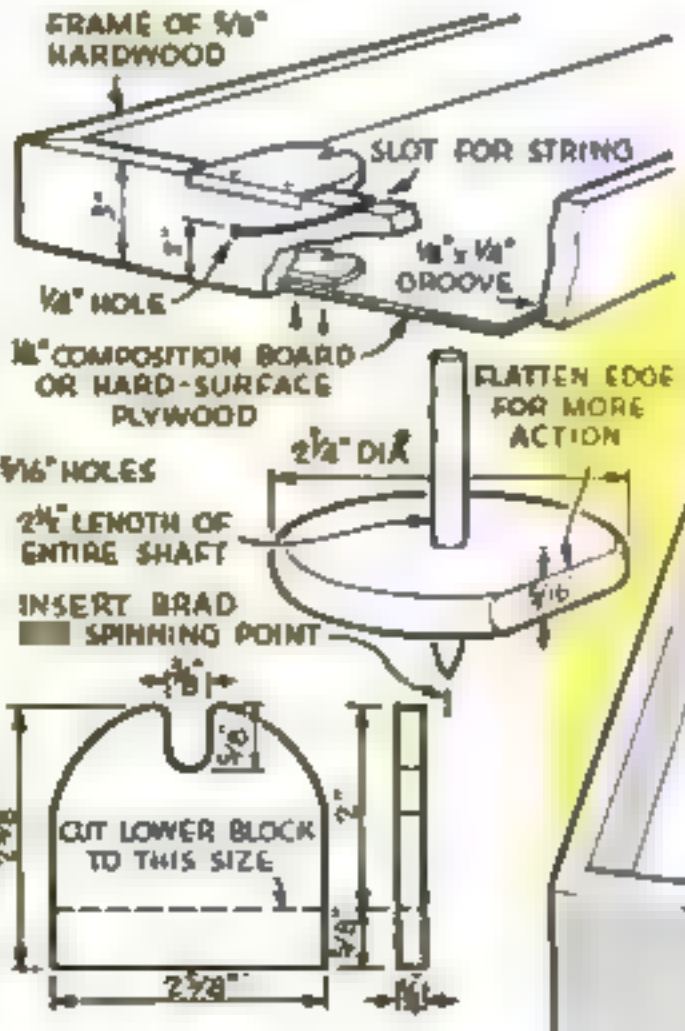
PLAY is started in this exciting new top game by winding a string around one of the tops and inserting the top in one of the starting blocks, with the other end of the string in the slot in drawing position. When the string is pulled, the top spins out of the hole and onto the board, finally coming to rest in one of the scoring holes. Scores are tallied according to the value of the holes. If the top lands in the center jack-pot hole, the game automatically is over. Players can spin in turn, or two tops can be spun simultaneously from either end of the board, providing livelier action and the possibility of unpredictable collisions.

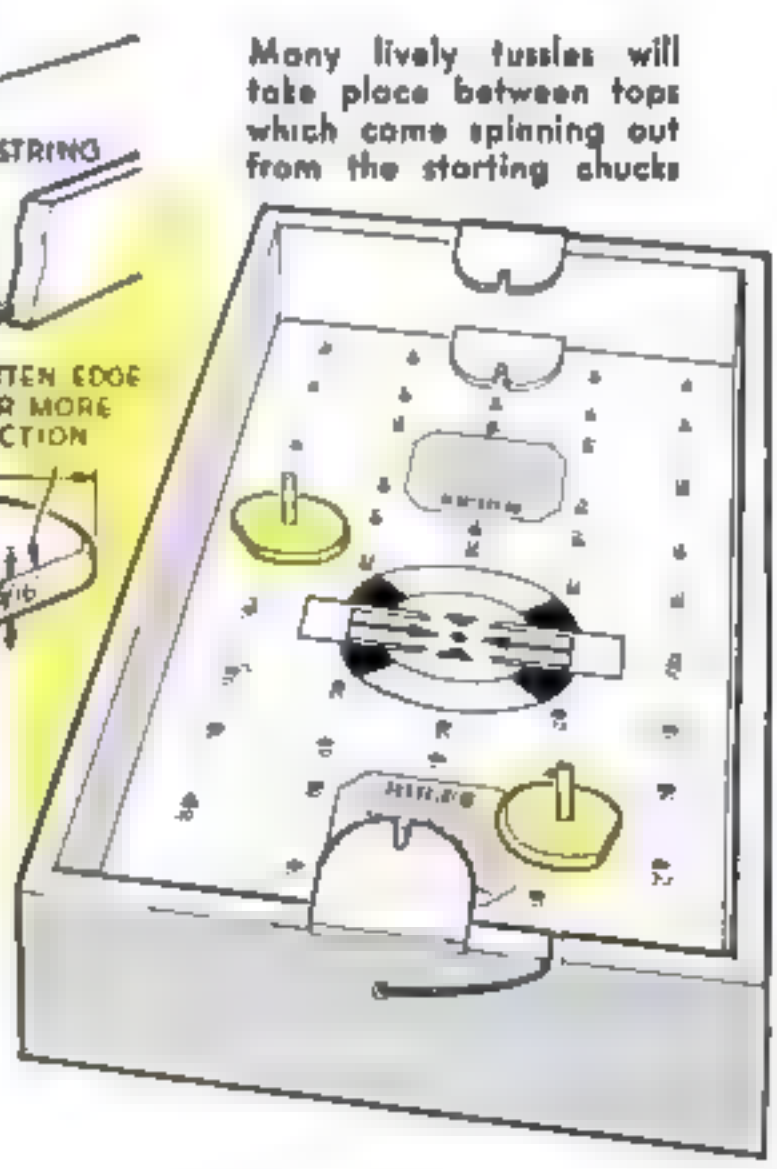
The playing area is made of hard, smooth plywood or composition board. First lay out and bore the holes, sanding off any feather edges on the upper rims. Mark hole values as shown in the drawing. Note that both the high-value and minus holes are near the center of the board. The numbers can be printed on the board with a lettering pen and black India ink, but first test to see if the wood fibers make the ink spread. If so, apply a coat of very thin shellac before lettering, and rub lightly with steel wool after it is thoroughly dry. The rules of the game are glued on the playing area, as shown, and then the whole surface is given a coat of white shellac, finished with a coat of varnish, and allowed to dry 24 hours.

Cut a groove in the hardwood frame, ½" from the bottom, for the play board. Bore the string hole in the endpiece and saw out the slot. The lower starting chucks are ⅝" shorter than the upper ones, so that the upper and lower notches will be brought into good alignment.

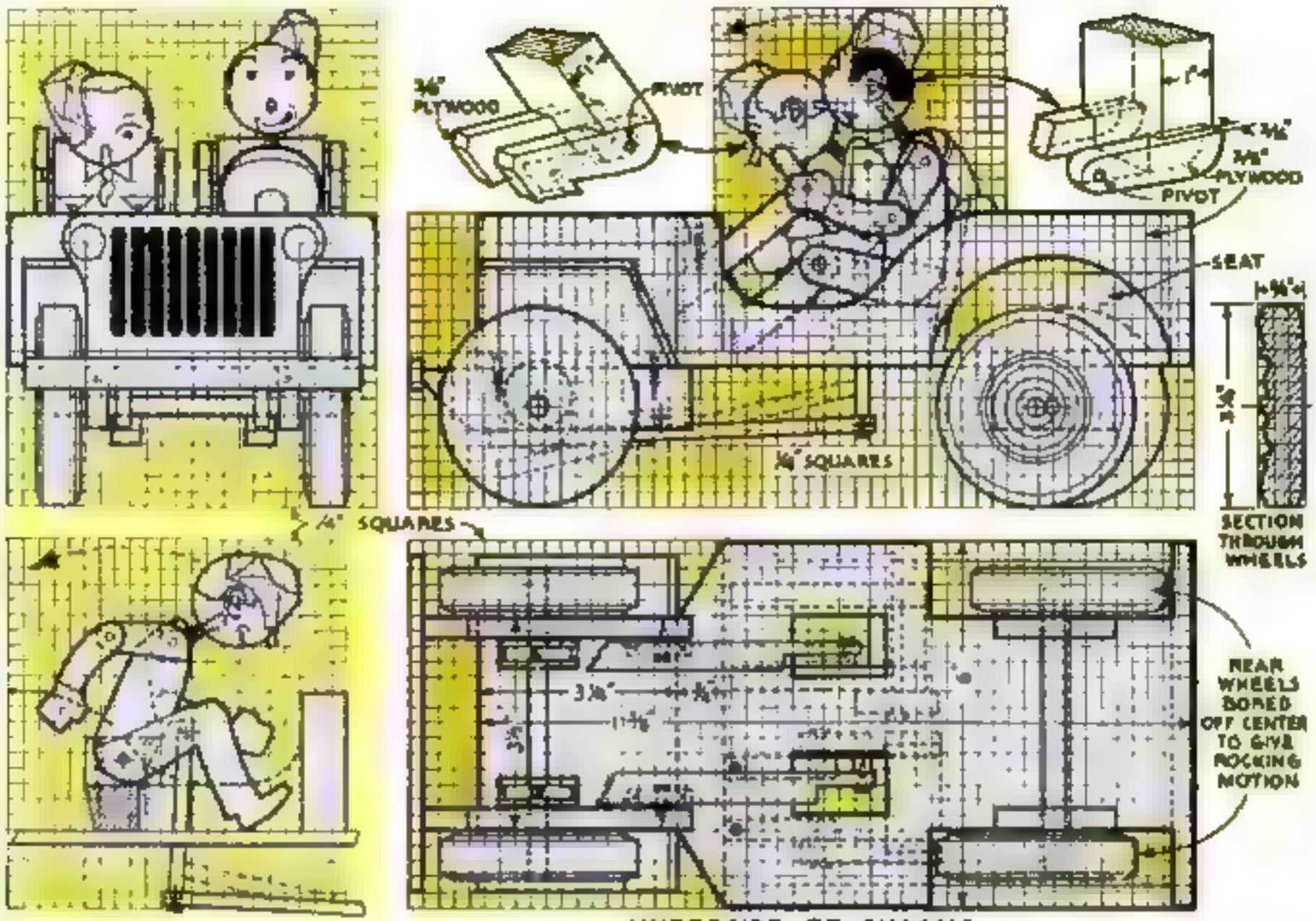
Next, assemble the frame around the playing area and mount the starting chucks. The lower blocks are fastened with screws from below, while the upper blocks are mortised in ⅛" on the frame and held with two ⅝" round-head screws. Apply a coat of varnish on the frame and blocks. Turn the tops from hardwood, with a flattened edge on each. The shaft is made of ¼" dowel glued firmly in place. For smooth spinning, insert a brad in the end. Decorate the tops with bright enamels set off with a few contrasting stripes.—O. E. OLSON.







Many lively tussles will take place between tops which come spinning out from the starting chucks



UNDERSIDE OF CHASSIS

TOY JEEP

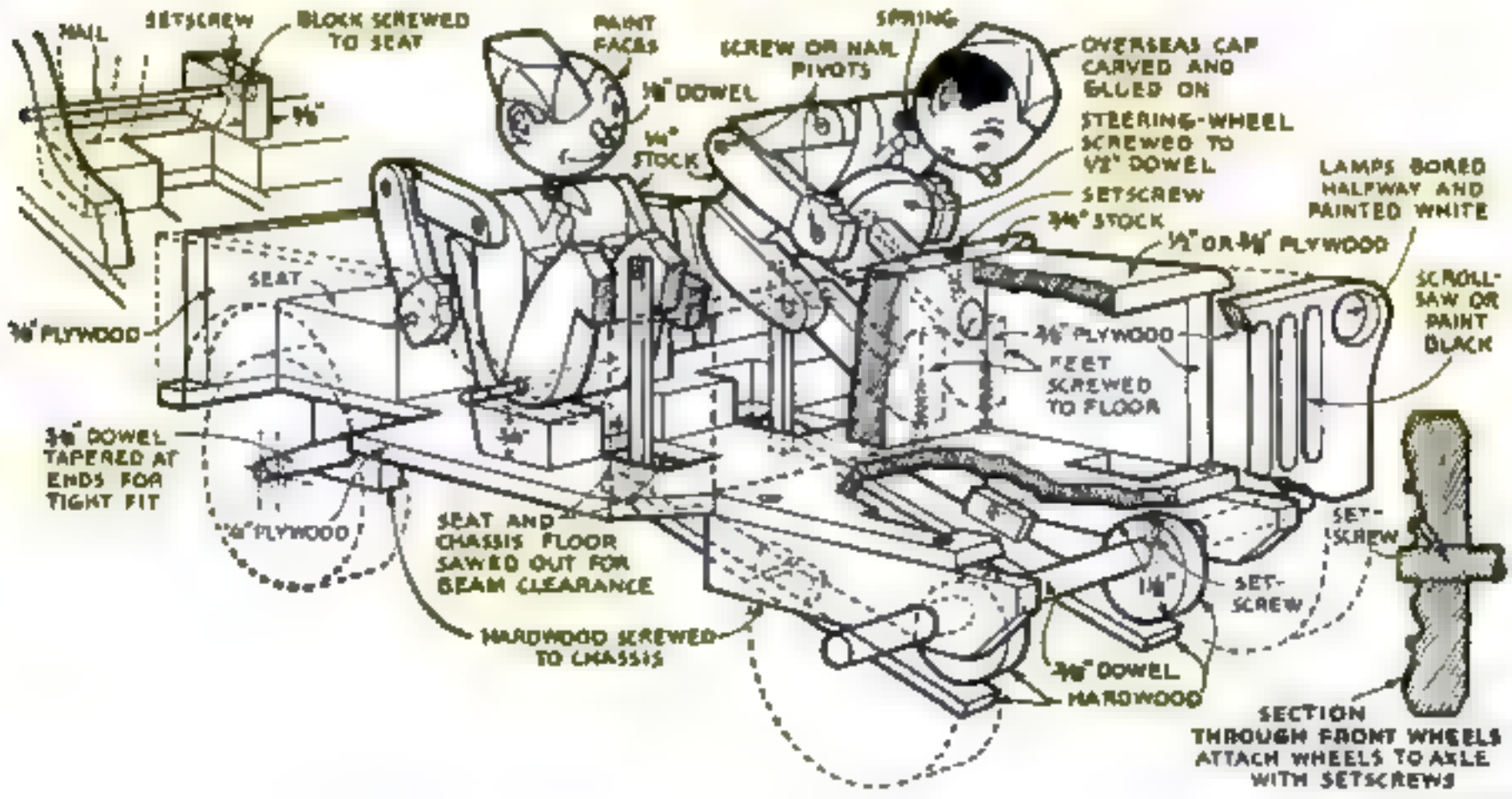
Jounces As It Is Pulled Along

By C. W. BERTSCH

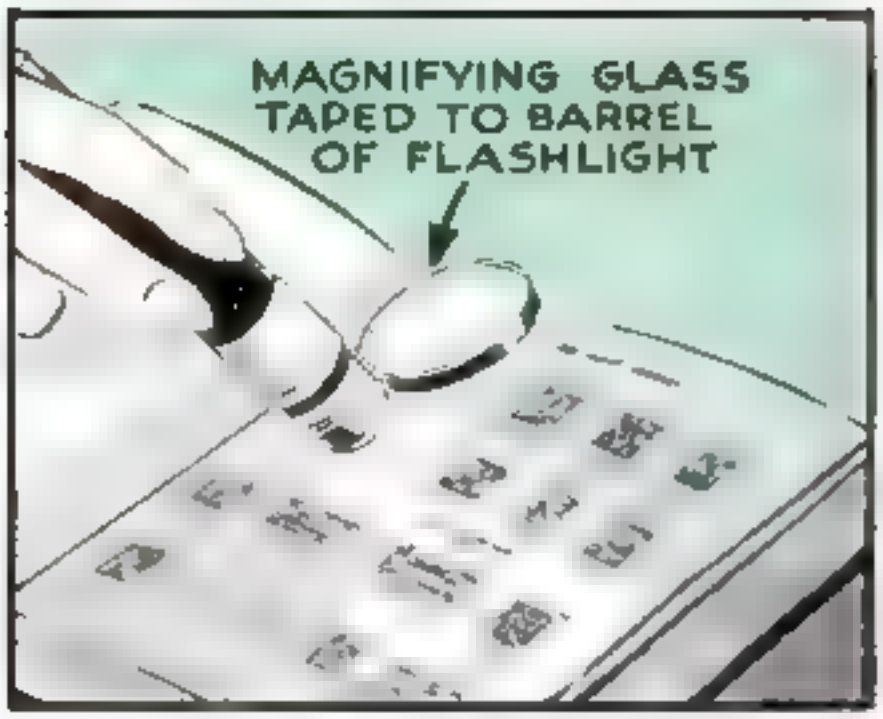
"JEEPERS! This road is bumpy," you can almost hear the toy soldiers say as, heads bobbing, one swings over the steering wheel while the other falls backward, clutching the side. Their jeep, bucking and rolling, can take it—and so can these bucking buck privates.

The amusing toy is constructed entirely from scrap wood, a few nails and screws, a few inches of a spring-type curtain rod, and glue. The bouncing action is caused by having the rear wheels off center, while the soldiers are made to bob by eccentrics on the front axle. If wood screws are used instead of nails for pivots and setscrews, the toy can be taken apart for repairs.

Paint the jeep olive green, the tires dark gray or black, and the uniforms tan, with brown outlining collars, ties, and pockets. Finally, use a small, pointed brush to paint in the soldiers' features.

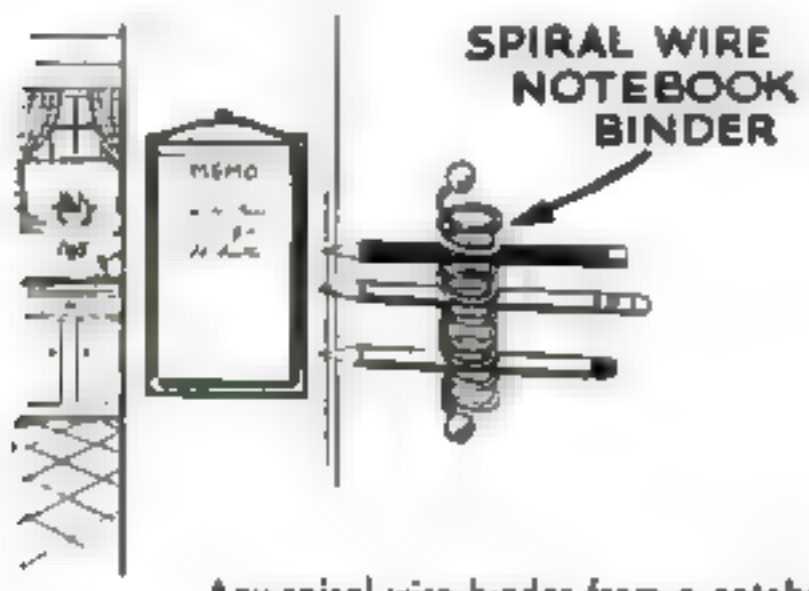


KEEPING COOL INSIDE

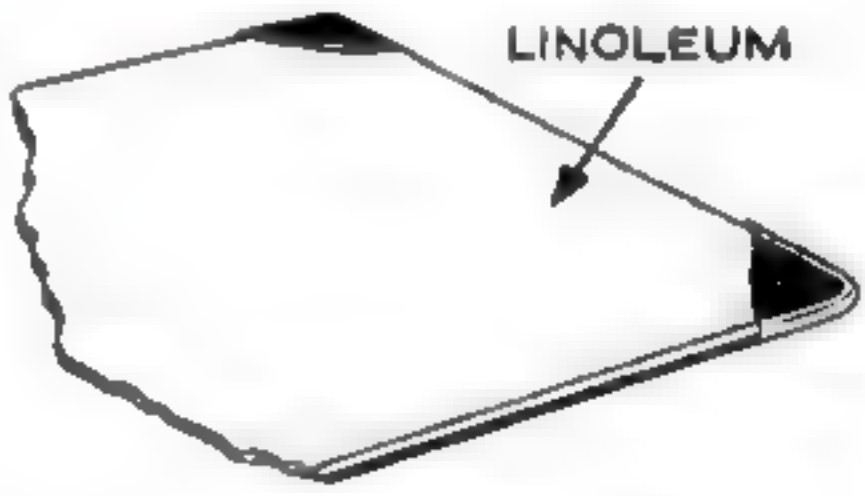


Taping the handle of a hinged magnifying glass to a flashlight barrel will be of help to hobbyists and others who have occasion to read fine print, vernier scales, and the like. The glass can be easily adjusted or folded back against the barrel

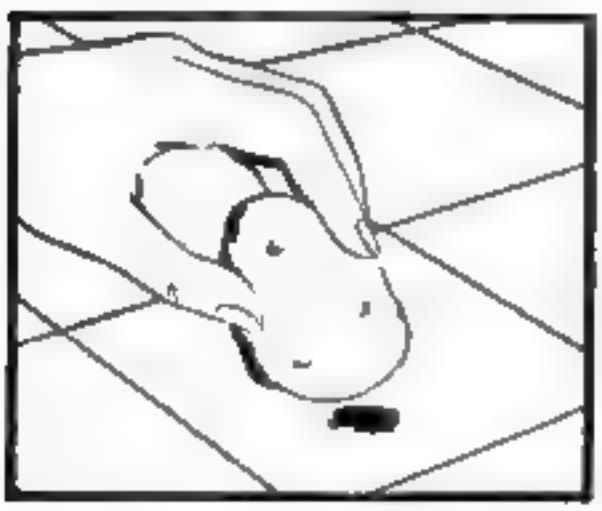
If the lid of a canister fits too snugly to be readily removed, try fastening a pot-lid knob at the center. This will provide a firm grip for removing even the most stubborn lid. To attach a knob, punch a hole in the lid to take the screw



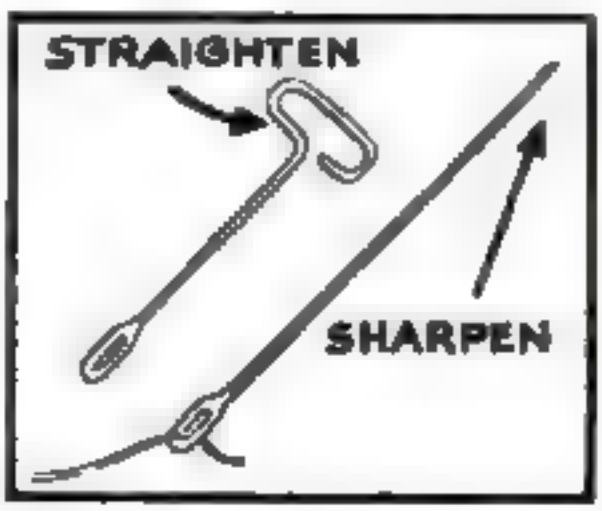
Any spiral wire binder from a notebook or a similar firm, light spring, will serve as a pencil holder if fastened to the wall near the kitchen memo pad. Loop the ends of the wire and attach with thumbtacks or upholsterer's tacks



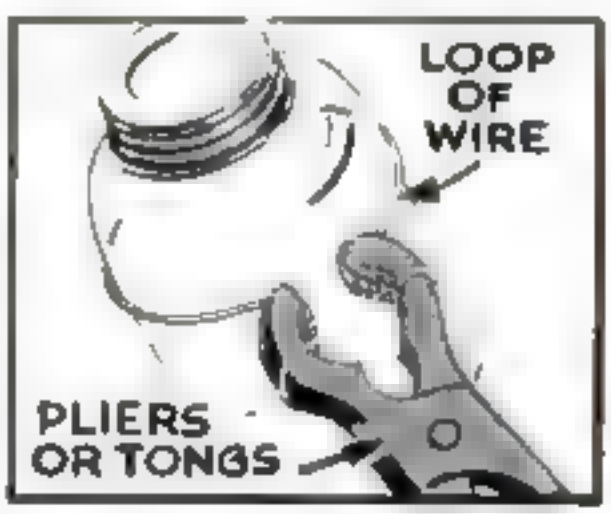
Linoleum cut from a scrap end out of the salvage box will serve as an unusually attractive filler for a desk pad. It will outwear a considerable number of blotters and it supplies a firm, smooth surface on which to write. You can keep it clean simply by an occasional wiping with a damp cloth



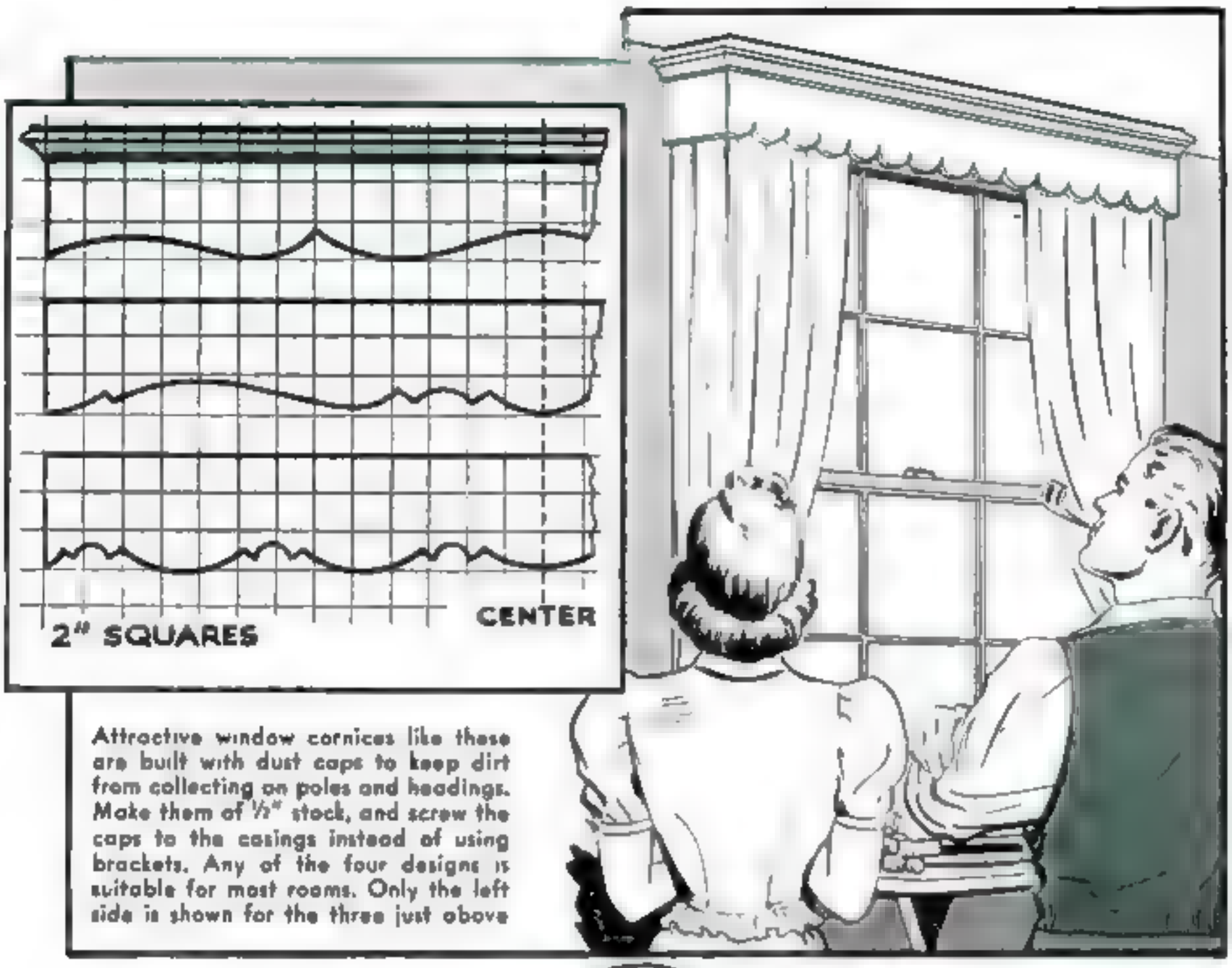
Iodine stains on linoleum can be removed with a small portion of raw potato. If left on a stain, the potato will absorb all of it



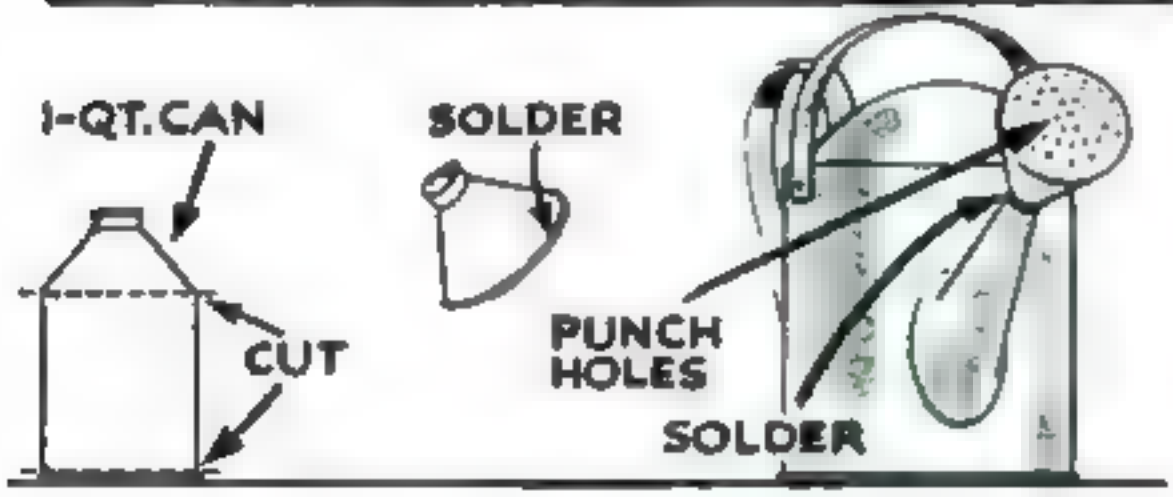
A coarse needle for sewing burlap can be made by straightening the handle of a key-type can opener. Sharpen the needle with a file



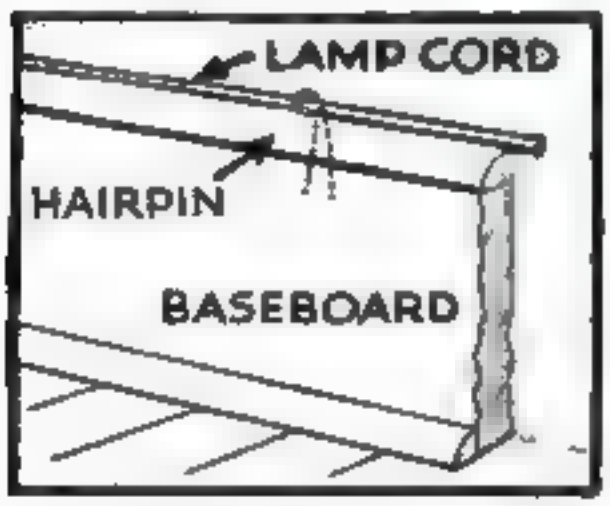
Tongs for canning jars may be made by twisting the ends of a proper-sized loop of heavy wire over the jaws of common pliers



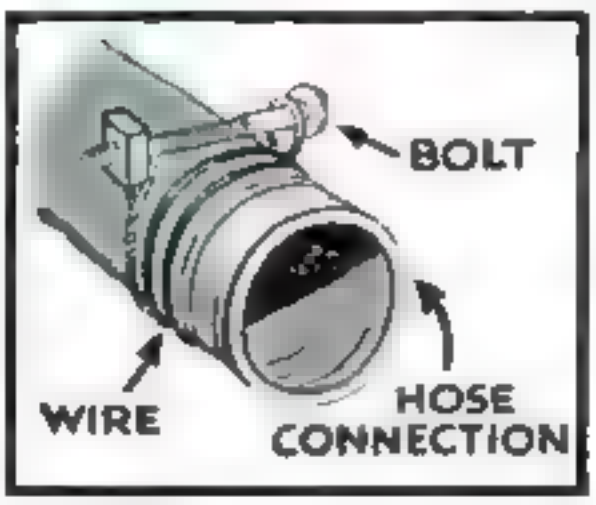
Attractive window cornices like these are built with dust caps to keep dirt from collecting on poles and headings. Make them of ½" stock, and screw the caps to the casings instead of using brackets. Any of the four designs is suitable for most rooms. Only the left side is shown for the three just above



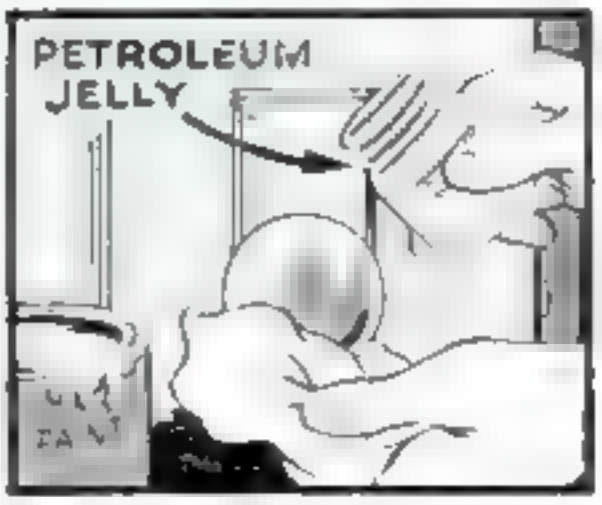
Should the perforated spout of a sprinkler be lost, you can use the top of a 1-qt. can like that shown at the left, if you happen to have one, to make a good replacement. Cut off the top and bottom of the can, and solder the round bottom piece across the flaring mouth of the funnel formed by the severed top. Punch the holes and solder the piece to the old pouring arm



Hairpins will hold a lamp cord securely on top of a baseboard if the pins are slipped over the cord and wedged behind the board



Hose clamps can be made quickly by forming loops in the ends of wire wrapped twice around a hose and tightened with a stove bolt



Before painting woodwork, rub a coating of petroleum jelly upon doorknobs and the like. It will let you clean off any splashes

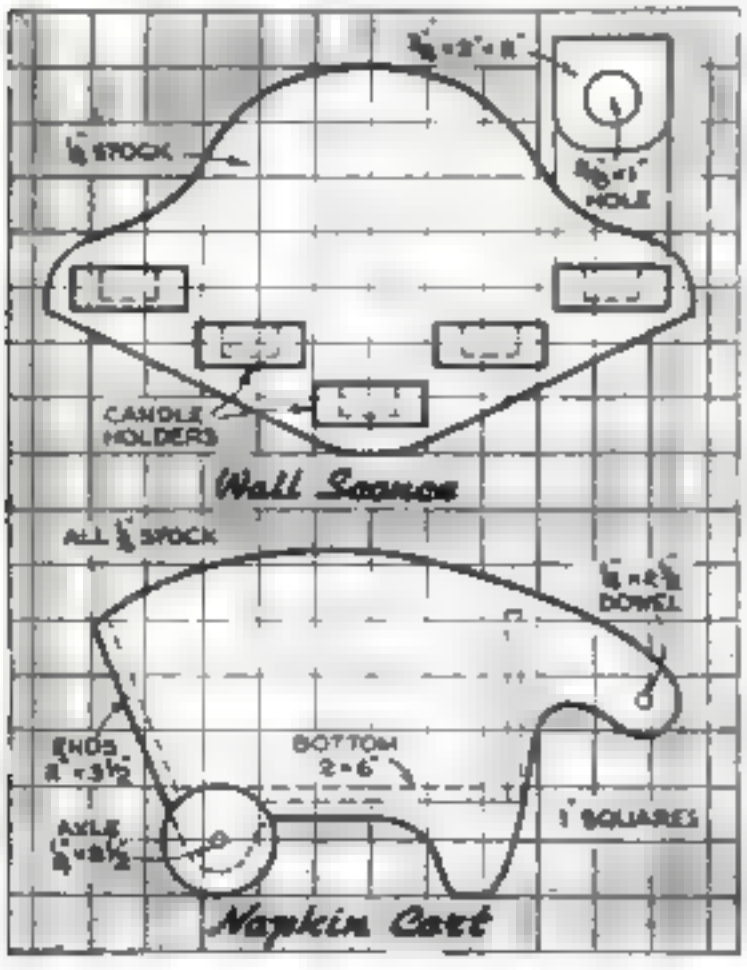
ONE-EVENING CHRISTMAS PROJECTS...PEASANT STYLE

FLOWERPOTS and holders decorated with bright peasant colors and designs will strike a gay note when arrayed on a window sill. Those at the right are embellished with lively primary hues. Each is designed for a 3" pot, but the dimensions can be changed to suit most requirements. Construction throughout is of ¼" stock.

The shallow holder looks best with a pot that's also gaily colored. The sides of this holder are high enough to hide the saucer under the pot, but not high enough to conceal the simple designs on the pot itself. A plain pot can be used in the taller holder, which is high enough to screen it entirely.

Also jigsawed from ¼" wood is the flat back of the five-candle sconce, while the candle holders are cut from ⅜" stock. Fasten the holders with screws driven through the back. Drill suitably sized holes for the candles. These candle sockets should be at least ⅝" deep, and the tops of the holders can be slightly hollowed out to help catch candle drip.

Details for building the sconce and napkin barrow at right are given in these drawings



These gay holders will ornament any winter window sill

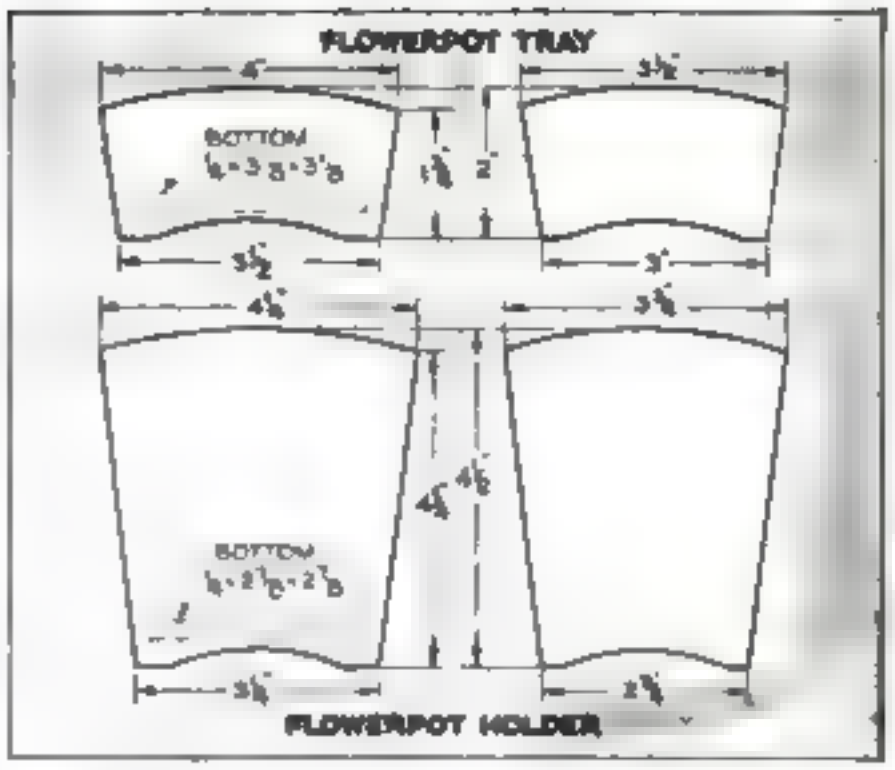
Brighten up a dark corner with this five-candle sconce

Roll out this barrow when your luncheon guests appear

As for the pushcart, which holds a portion of a package of paper napkins folded just as they are packed, make it, too, of ¼" wood. The wheels are put on for appearance only, since they are glued to the dowels and do not turn. The handle is a short length of dowel glued in place.

Apply two coats of quick-drying enamel in ivory or white as a background to show off the designs to good advantage. The designs themselves, in bright reds, blues, and greens, can be done with ground oil colors thinned with a little turpentine and varnish, or prepared enamel may be used if the surfaces are held horizontal to avoid running.

If you wish to simplify the decorating, it is possible to achieve attractive effects by using suitable decalcomania designs on the white or ivory background.

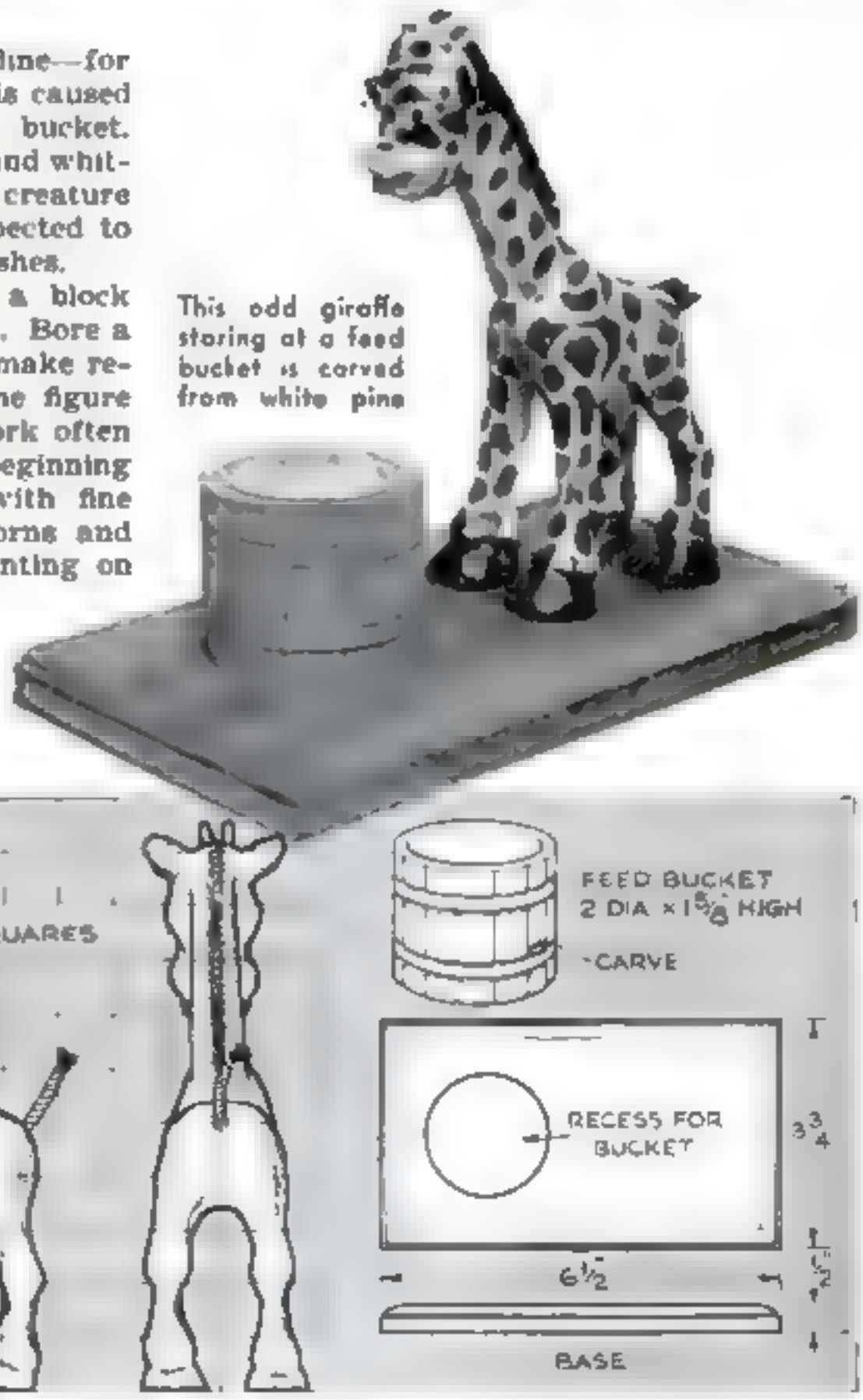


Plans for the two pot holders on the facing page

WHITTLED GIRAFFE ORNAMENTS ASH TRAY

THE dubious expression of Geraldine—for that's this giraffe's first name—is caused by what she beholds in the feed bucket. Smokers will covet this accessory, and whittlers will enjoy making it, but a creature like Geraldine could hardly be expected to fancy a hearty meal of cigarette ashes.

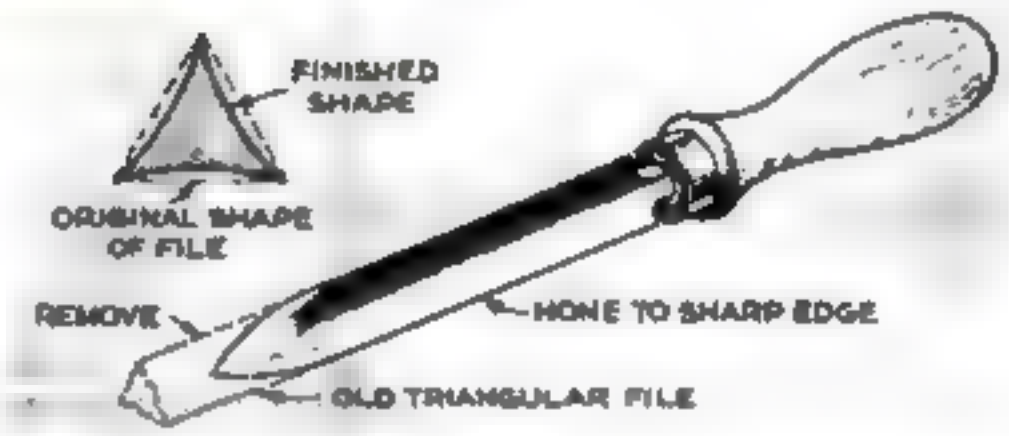
Lay out Geraldine's profile on a block of white pine 1¾" by 3½" by 5½". Bore a series of holes between the legs to make removal of wood easy, and shape the figure with a sharp knife, turning the work often and completing one detail before beginning the next; then curry the body with fine sandpaper. Use toothpicks for horns and white map tacks for the eyes, painting on black pupils. Mane and tail are tufts of yarn glued in small holes, and the spots are stained. The feed bucket is turned, with carved staves.—E. W.

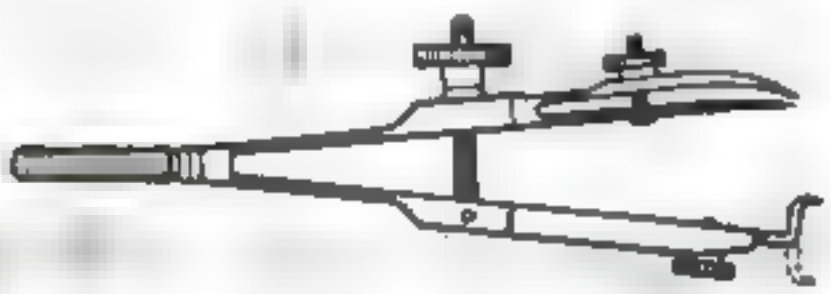


This odd giraffe staring at a feed bucket is carved from white pine

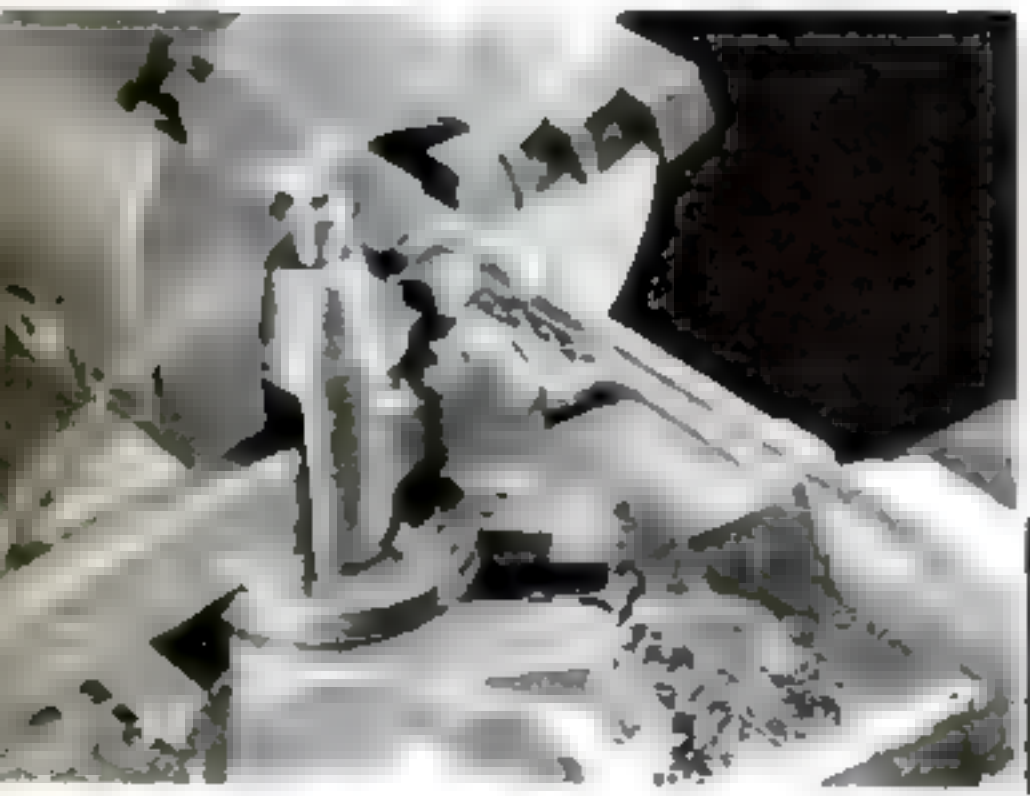
A CROSS-SLIDE SHIELD on a lathe may help to prevent damage to the cross-feed screw. On certain lathes, advancing the cross slide eventually uncovers this screw and thereby exposes it to chips which may work into the threads. Protection against this may be secured by a celluloid shield which is held by a bolt to the cross slide. Being transparent, the shield does not obscure the micrometer collar when the cross slide is moved toward the operator. Drill a No. 7 hole in the end of the cross slide and tap it ¼"-20 for the screw. The shield should be as short as possible to prevent interference with the cross-feed handle. Sheet celluloid can be bent around a moderately hot knife blade to the requisite right-angle form.—W. E. B.

SCRAPERS for putting the finishing touches on metallic surfaces can be made from worn triangular files. The three surfaces of an old file are hollow ground on a grinding wheel and brought to a point for use in narrow openings. The tool will have long-lasting edges, ideal for removing scratches, high spots, and burrs.—EDWIN DREWITZ.

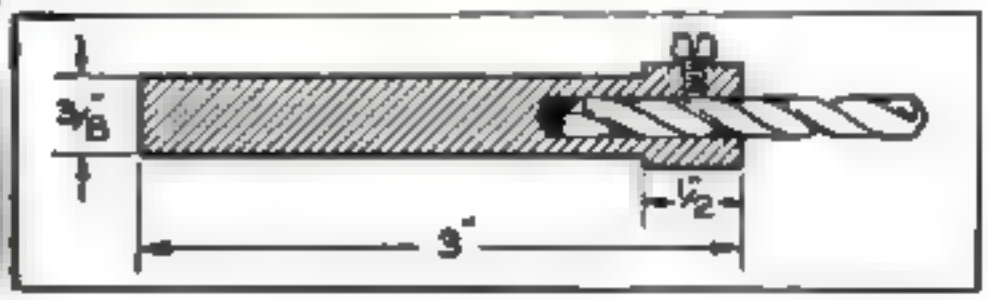




SMALL CIRCLES can be drawn with precision by using a sewing needle bent as shown at the left in a bow pen. The needle should be heated to a cherry red and allowed to cool gradually before bending. With this, a circle can be drawn which is scarcely larger than the point. By reversing, the needle, as dotted lines show, you can draw extra large circles.—SAMUEL T. TILTON.



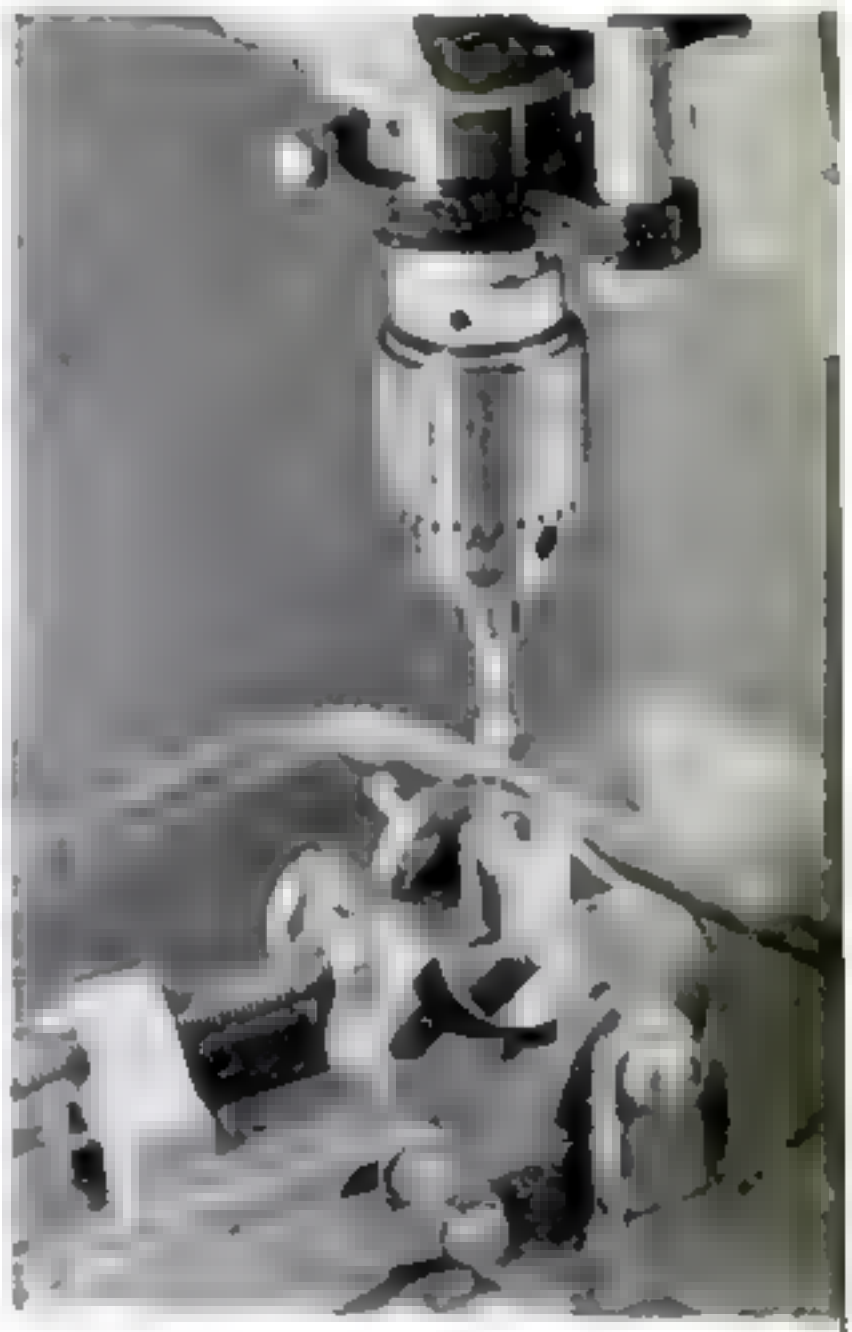
BROKEN TWIST DRILLS or pieces of drills at least an inch long can be salvaged by means of the simple holder shown below. Although not capable of making deep holes, the drills so saved will be found useful for sheet-metal work, for centerdrilling, and for other jobs not requiring great penetration. The new shank is made of a steel rod, shouldered as shown below, and drilled to be a close fit for the stub. It is then drilled and tapped for a setscrew.—C. W. W.

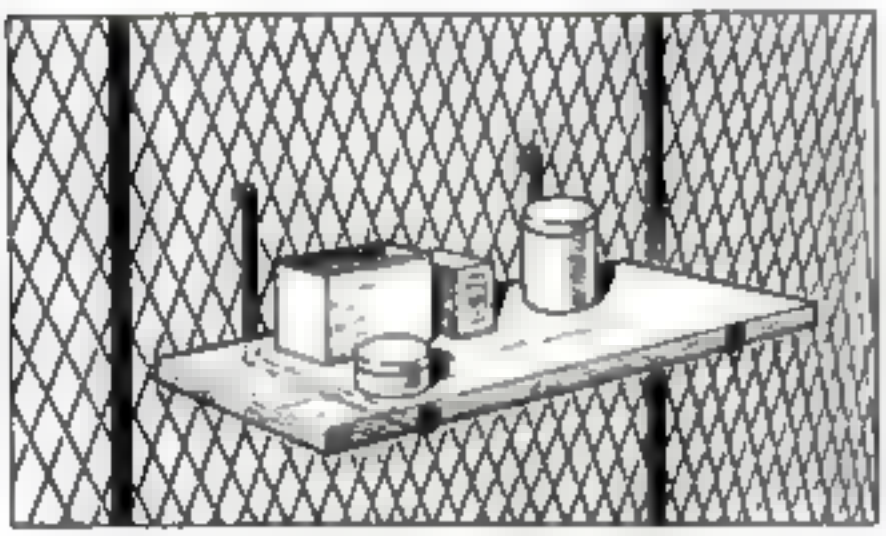


New SHOP IDEAS

FINE DRILLS that are too small to fit properly in the jaws of a drill-press chuck may be gripped instead in a pin vise which in turn is held in the drill press. By this method extremely small drills, No. 60 and finer, may be accurately mounted in a standard chuck. High speeds, fine feed, and a well-balanced chuck are essential in using such small drills. Rigidity of the work being drilled is important, as is the absence of end play in the drill-press spindle. The correct coolant or lubricant should be used with fine drills.—C. W. W.

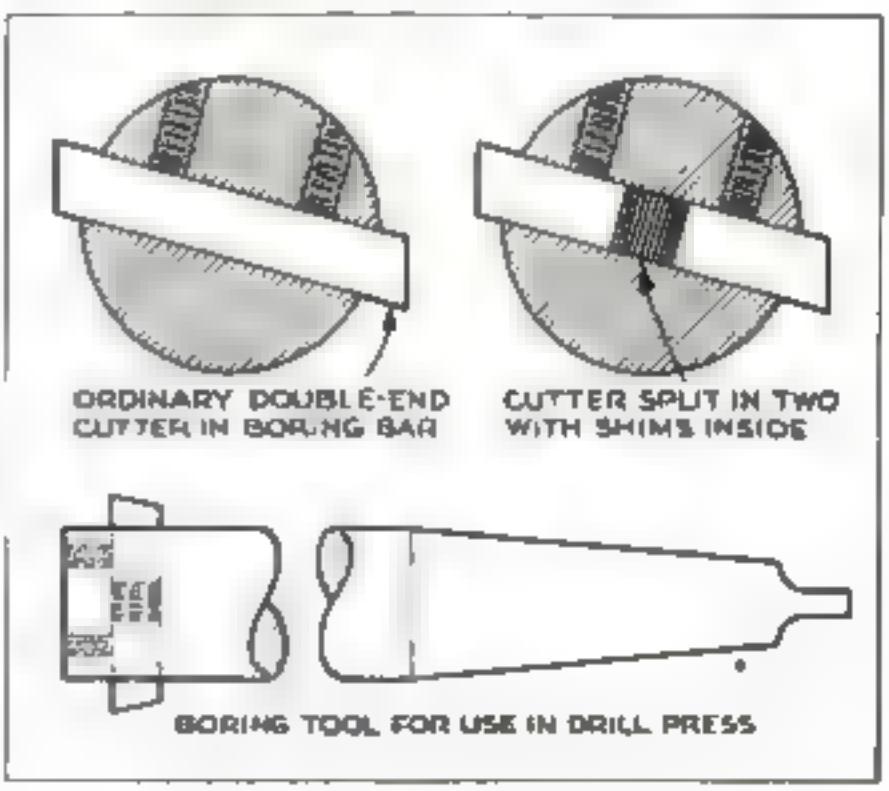
BUSHINGS can be pulled from blind holes with a device designed by Robert Eckhart, of Peoria, Ill., and shown at the left. The semi-circular key is pivoted in a slot at the end of the stud. A wire which passes through a longitudinal slot turns the key at right angles after it has been inserted in a bushing. A pipe spacer is slipped over the stud and the nut tightened against it to pull the bushing





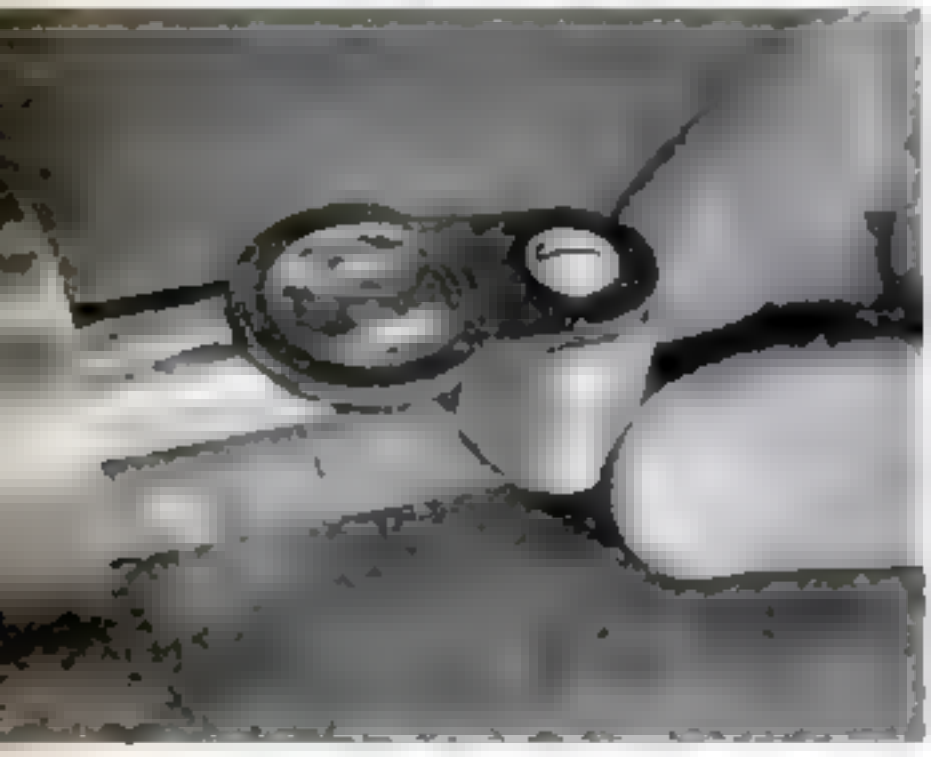
PORTABLE SHELVES for use in tool cribs were built by one supervisor who found himself cramped for sufficient shelf space. Made in various sizes, the shelves can be hooked to the enclosure screening wherever needed. Small cabinets and compartments may be constructed for use in the same manner. The shelves are built of wood and are attached by screws to two or more hook-shaped pieces of strap iron which are spaced to fit the screening.—KENNETH MURRAY

DOUBLE-END BORING CUTTERS can be adjusted for wear if made up of two pieces separated by shims as shown at the right. Worn or broken cutters may thus be utilized. On heavy boring cuts, a bar fitted with an adjustable single-end cutter will often spring excessively, while a double-end cutter may have to be discarded when it wears undersize. But if it is divided into two parts and shims are placed between them, the double-end type of cutter is readily adjustable. It can best be sharpened between centers on a tool grinder, after the needed shims have been placed inside and the setscrews tightened. The same idea can be adapted for a tool to be used in a drill press for counterboring or spot-facing.—D. C. HARRIS.



The magnifier above is valuable for delicate work

A magnet holds this lens to steel or iron surfaces



Above, a slotted base clips a lens to a steel rod

The lens below helps increase accuracy on a lathe

LENSES LEND

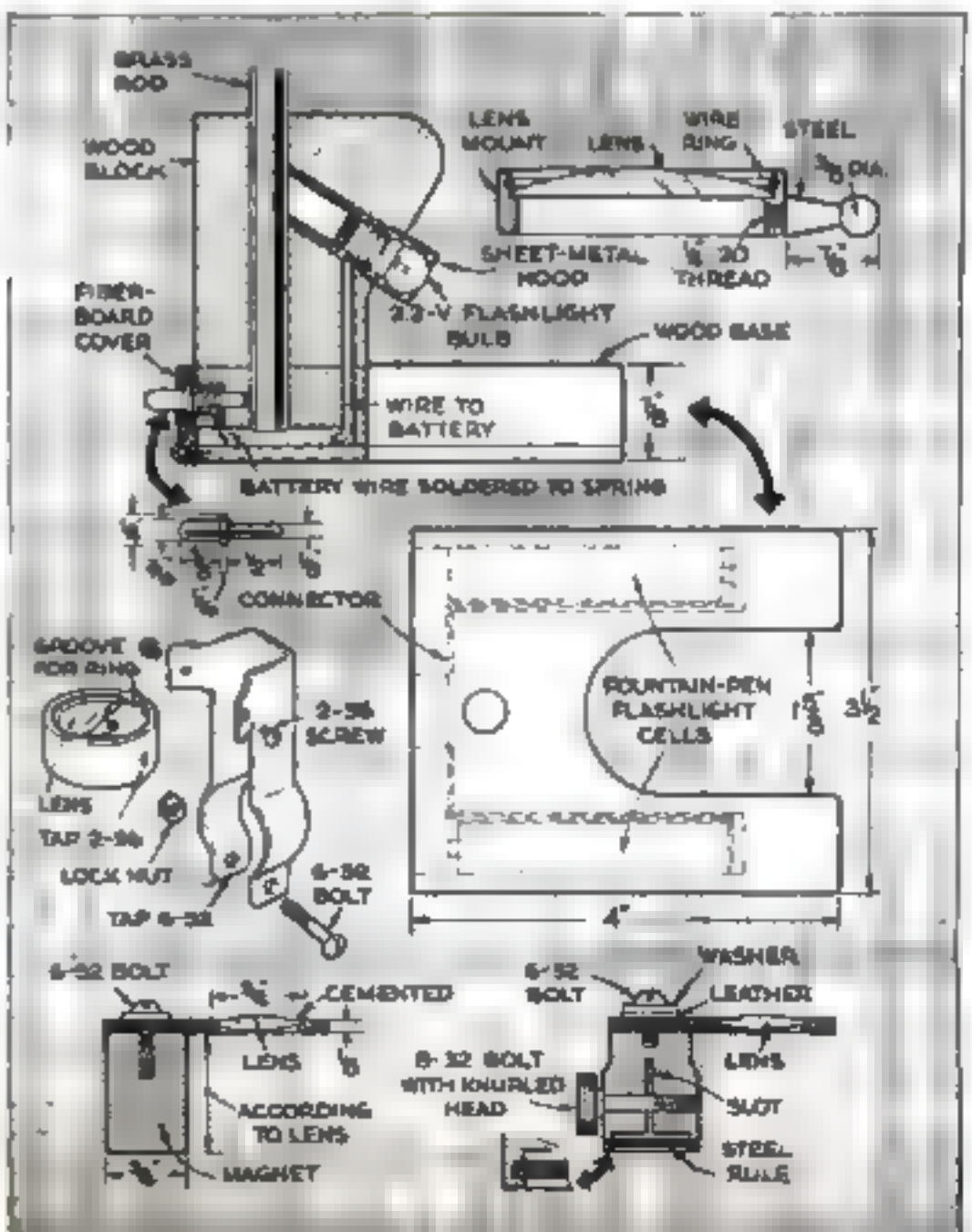
Four Optical Aids Toward

By WALTER E. BURTON

INEXPENSIVE magnifying lenses are used in these simple optical aids that will save time and eyestrain as well as increase accuracy in almost any workshop or laboratory. Scrap materials may be utilized for the most part in their construction, while the lenses themselves may be taken from discarded optical devices or purchased for a few cents apiece from dealers in chipped-edge lenses.

A general-purpose magnifier, mounted on an adjustable stand, is pictured at the upper left and on the facing page. The advantage of the built-in light shown with it is, of course, that the intensity of illumination needed for fine work is supplied wherever the magnifier is used, without need for readjustment of room lights. Any positive (magnifying) lens which is 2" or more in diameter and has a focal length of 5" to 8" is suitable.

The base of the magnifier is a horseshoe-shaped piece of ⅞" hardwood. On this an upright metal rod is mounted, its length governed by the normal working distance of the lens. A metal or plastic cell is provided for the lens. A simple and satisfactory way to make one is to machine a recess in a brass, steel, or plastic



A HAND IN THE SHOP

Greater Precision in Inspections and Measurements

ring, and then cut a shallow groove in the recess to receive a spring-wire retainer.

From ⅜" bar stock, machine a ball arm 1" long which screws into a hole tapped in the lens cell. The ball fits into a socket formed by the countersunk holes near the end of a pair of steel plates, of the type usually sold at hardware counters as "repair strips." These strips, separated by a spacer 5/16" long, are held together by two bolts located near the end holes. The other ends engage a ball driven onto the upright.

The lighting system consists of a lens-type flashlight bulb, a cylindrical shade, a push-button, and two pen-sized (AA) cells which slip into 5/16" holes drilled in the "toes" of the base. Depending on the uses to which the magnifier will be put, it may prove preferable to use a switch rather than a button, or a 110-volt bulb instead of the battery arrangement.

A magnifier with a magnetic base which holds it on any iron or steel surface also makes a handy shop instrument. As shown in the drawing, it consists of a lens cemented in a plastic or fiber holder which is screwed to a cylindrical magnetic base. Alnico alloy, used for the base illustrated, cannot be machined; but since a hole ran through this magnet, it was possible to insert a wooden plug and to attach the lens holder with a wood screw. You may, of course, magnetize a piece of bar stock yourself, or perhaps a suitable magnet can be salvaged from an old permanent-magnet radio speaker.

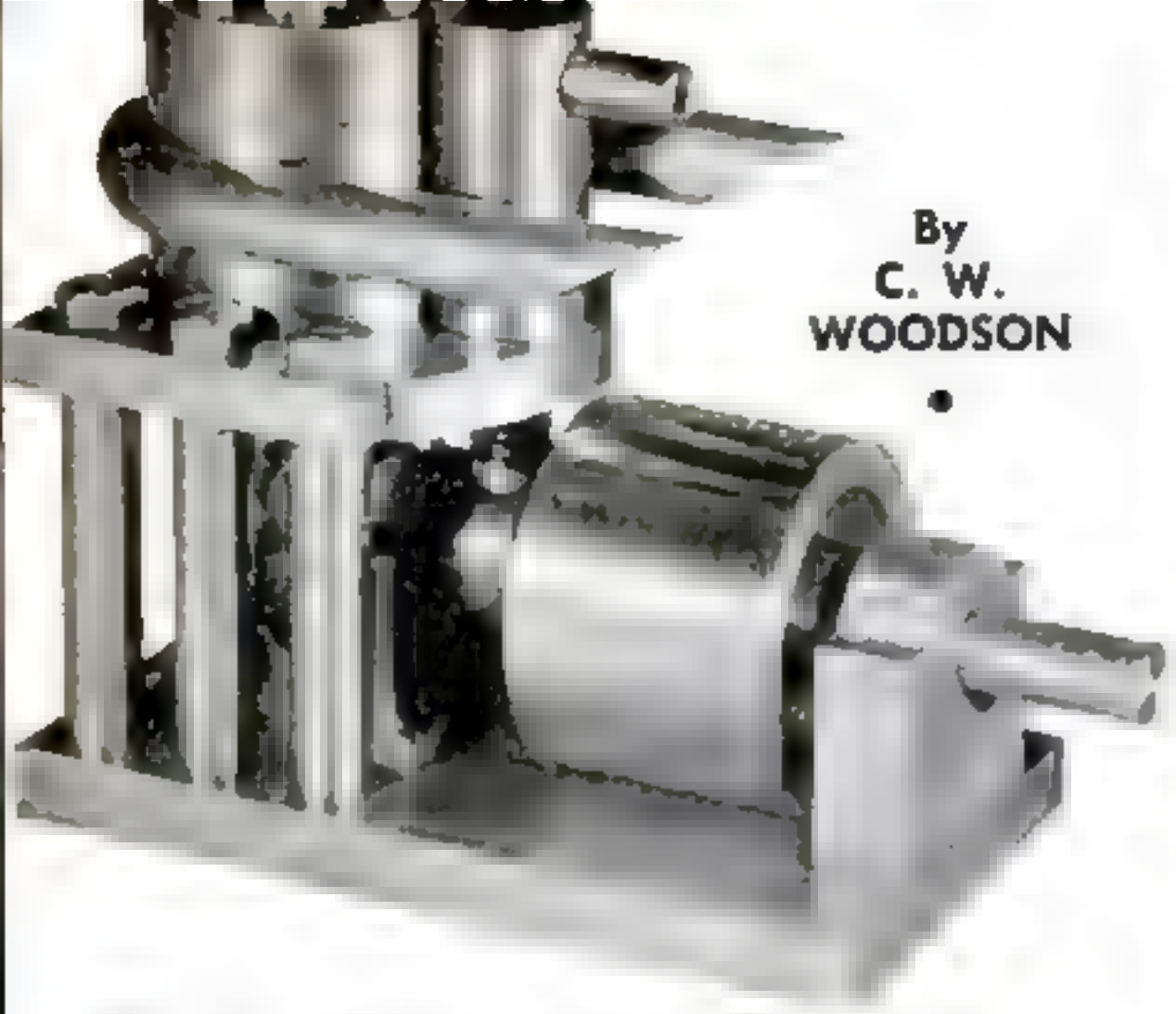
A convenient variation on the magnetic base magnifier is another type which can be clipped to your favorite steel rule. A plug-shaped base of brass, aluminum, or steel is provided with grooves which receive the edges of the scale; those in the model shown were formed with a milling cutter mounted in a drill press. The base was also split part way along its axis, and partly threaded for a thumbscrew to hold it in position.

One of the handiest locations for a magnifying lens is over the graduated collars on the micrometer screws of lathes and other shop machines. The lens shown, mounted on the cross slide of a bench lathe, has been found to save both time and eyestrain. The lens ring was machined from a piece of brass tubing, while the holder to which it is attached was bent from sheet metal.

The dimensions will depend on the diameter and focal length of the lens used. However, it should be borne in mind that the lens is best mounted at a distance from the surface to be magnified which is slightly less than the focal length of the lens.

Details in the construction of the general-purpose magnifier are shown below. Note that the lens is held in its cell by a spring-wire ring which fits into a recess. The lens might also be cemented in

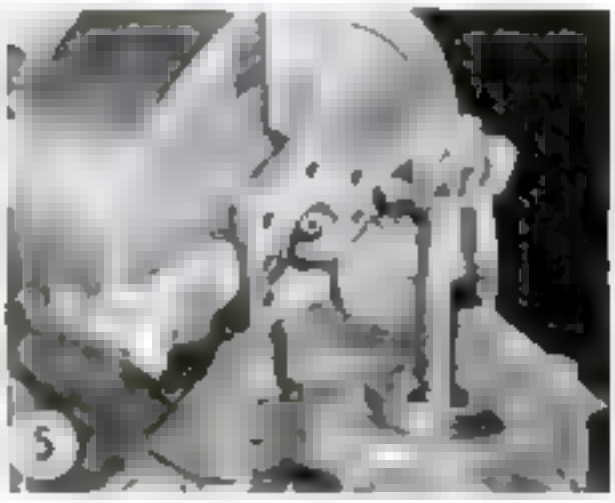
A built-in lighting system is helpful in the general-purpose magnifier because it gives satisfactory light for meticulous inspections without requiring any change in room lights



By
C. W.
WOODSON

LITTLE HUSKY

A High-Speed Steam Engine That Requires No Castings



MODEL engines, favorite projects with many workshop enthusiasts, involve so much interesting hand and machine work that the making of one is almost a shop course in itself. This little high-speed steam engine can be built from scrap without the use of a single casting. Powered by a model boiler of medium size, it will do yeoman's service in driving a model generator or small boat. For testing or display purposes, it can be operated on compressed air from a paint-spray compressor, tire pump, or shop air line.

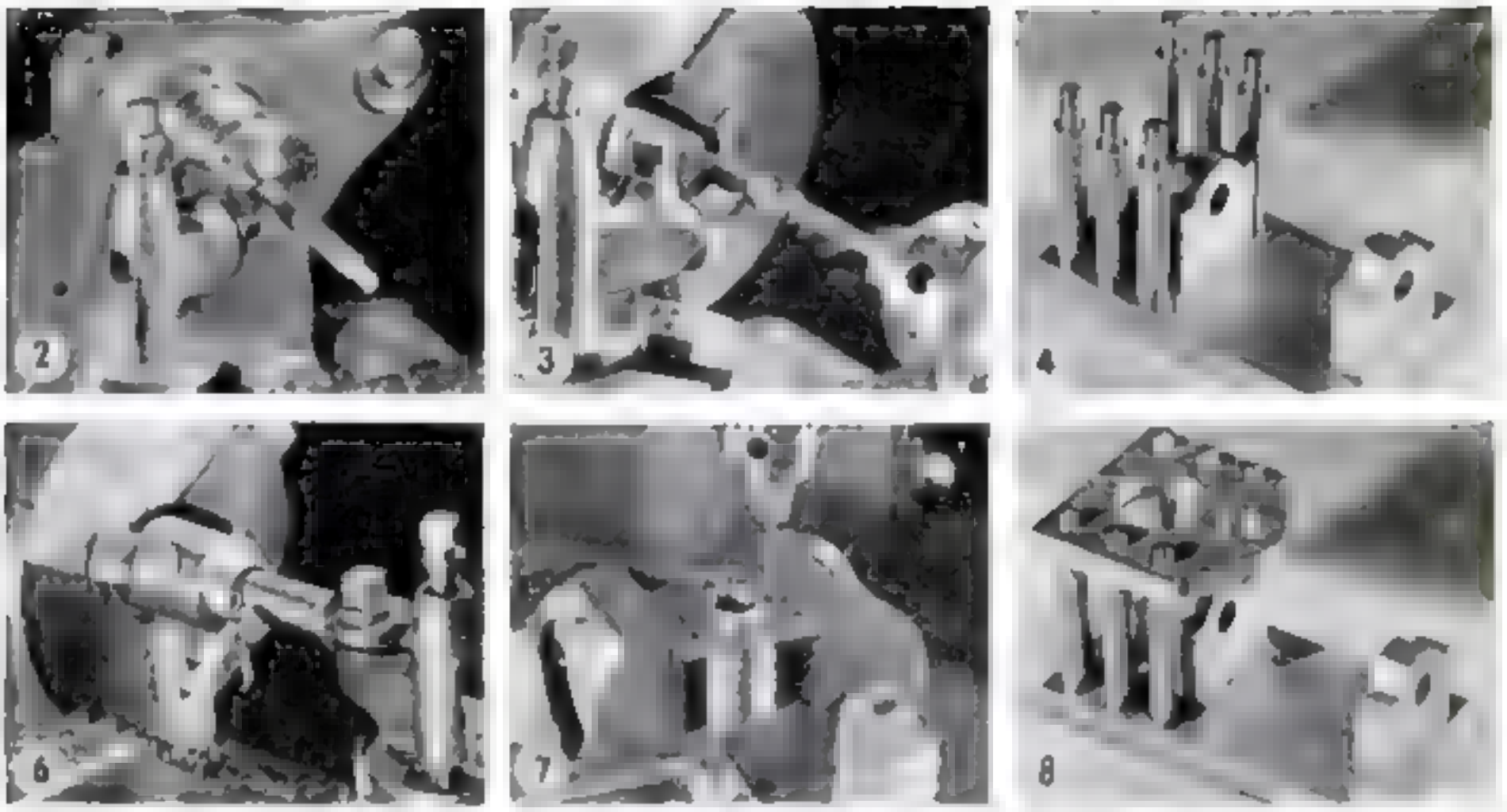
The dimensions given can be altered as necessary to permit the use of different stock thicknesses than those specified. This should not affect the design or efficiency of the engine, but it may be necessary to relocate the ports or alter the length of the piston rod in order to secure proper timing and correct piston travel.

Two pieces of flat stock are needed for the cylinder plate and the base. Square these with a file or on the shaper. Lay out the center lines for the column and bearing holes and file the cylinder plate to the shape shown in the drawing. Clamp both pieces together in the drill-press vise (Fig. 1). Run a No. 21 drill through both parts at the same time for the column holes. Tap those in the base 10-32 and open out those in the cylinder plate with a No. 9 drill to clear a thread of that size.

The columns can be turned from 5/16" stock held in a collet chuck (Fig. 2). A sheet-metal gauge, such as is shown in the drawings, is helpful in turning all six to exactly the same length across the shoulders. Polish each with fine emery cloth and thread both ends 10-32.

If regular stock hexagon nuts to fit the columns are not available, they can be made up in the lathe from 5/16" hexagon stock. Chuck this as in Fig. 3, drill a No. 21 hole through, tap it, and chamfer the corners slightly before cutting off each nut.

Both main bearings must be accurately squared across the bottom. If the lathe is the only machine tool available, this can be done by machining them in a four-jaw chuck or by the use of a milling attachment. Drill the bearing holes 1/64" undersize through both parts at once while they are clamped together. After screwing the



bearings fast to the base, as shown in Fig. 4, run a 5/16" reamer through both shaft holes at once.

The cylinder plate can be chucked in the lathe as in Fig. 5 for boring out the cylinder hole. After drilling the hole for the valve chamber, lay the plate aside until the cylinder is ready.

This can be turned from a solid bar or a heavy bushing (Fig. 6). The inside must be lapped, reamed, or bored to a fine finish. Use a boring tool sharpened to a V-point and then rounded off slightly with an oilstone. Take very light finishing cuts, using a high spindle speed and a very fine feed. Brass or cast iron can be bored dry, but a good cutting oil should be used for steel.

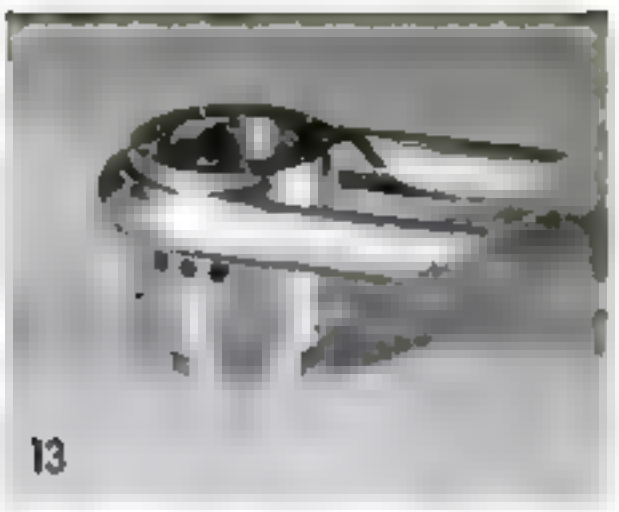
Slip the cylinder into the plate and drill through the latter into the cylinder with a No. 50 drill as in Fig. 7. Tap the eight holes in the cylinder 2-56, but open out those in the plate with a No. 42 drill. The plate can then be mounted on the columns, as shown in Fig. 8.

To complete the cylinder, form a ⅜" flat with a file or on the shaper (Fig 9) so as to face the hole drilled for the valve chamber in the cylinder plate. Then drill the exhaust ports as shown in Fig. 10. The cylinder head is easily turned from a small disk (Fig. 11). Snap the finished head on the cylinder and use a No. 50 drill to make the holes for the retaining screws, running it through into the cylinder as shown in Fig. 12. Here also, tap the holes in the cylinder 2-56 and open out those in the head to clearance size.

Make the exhaust manifold of a piece of brass or copper tubing by cutting away part of one wall. Bend it around the cylinder as shown in Fig. 13; then put it aside to be brazed in place at the same time as the valve chamber.

Turn the latter from solid rod, drill it to a depth of about 1 7/32", and finally ream it to a smooth finish. Form a small flat on one side to match that on the cylinder; then braze or silver-solder these parts and the exhaust pipe together. Drill the steam port through both walls of the valve chamber into the cylinder.

The valve rod, although a simple lathe turning, must be a smooth-running, steam-tight fit in the chamber and should be cut a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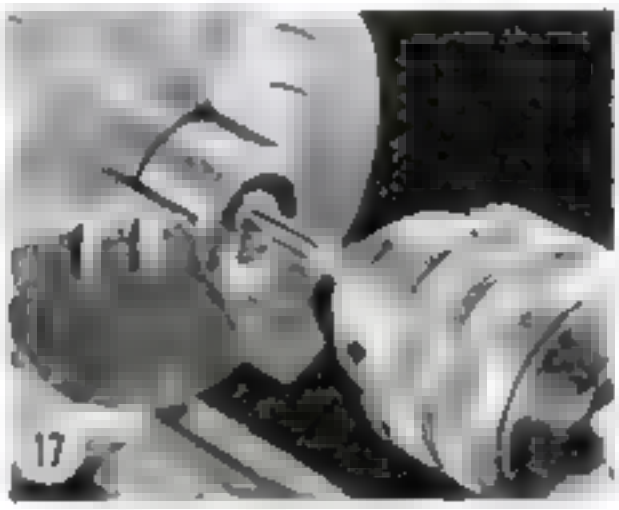
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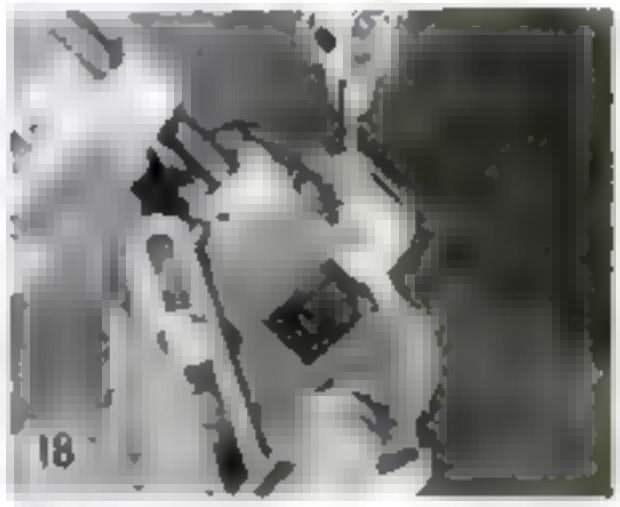
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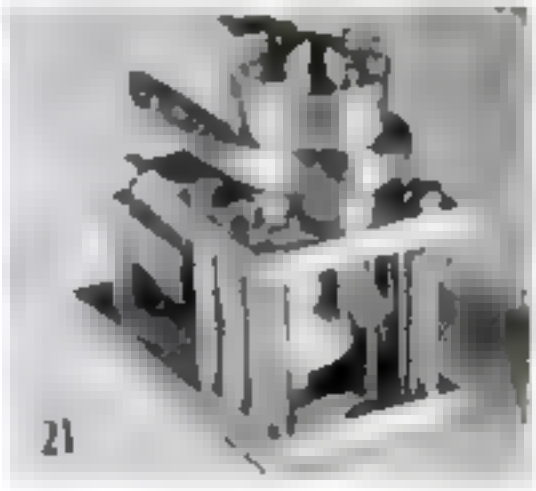
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little longer than shown so that the length may be adjusted after a trial assembly of the engine. The button that rides on the cam can be hardened if desired, and the spring can be made from piano wire if a suitable one is not available.

Turn the cam from a piece of steel and file the flats to shape by hand. A 4-36 setscrew will serve to lock it on the crankshaft. If the builder wishes to experiment with various lead and cutoff combinations for the utmost steam economy or power, several cams might well be turned up at this time.

The piston can be turned from solid stock by boring out the inside. Make the outside a snug fit in the cylinder, which may be used as a ring gauge. Turn the oil grooves with a pointed lathe tool; then cut off the piston, as shown in Fig. 14. Reverse it in the chuck to face off the head. Drill the hole for the piston pin with the part clamped in the drill-press vise (Fig. 15) or in the crotch center on the lathe. Cut the piston pin from drill rod large enough to be a push fit in the holes and slightly shorter than the diameter of the piston so that it will not project and score the cylinder.

As shown in the drawings, the connecting rod can be built from ⅛" flat stock, additional pieces being soldered to both ends to increase the bearing surfaces.

The crankshaft is 5/16" rod. Chuck this in a collet, if possible, to centerdrill the end, which should then be turned down to ¼". Rivet the crank disk to this end, rechuck the shaft, supporting it with the tailstock center, and machine the crank disk concentric with the shaft (Fig. 16). The crankpin should be threaded and screwed tightly into the disk. It is tapped for a small retaining screw. A washer under this keeps it from unscrewing.

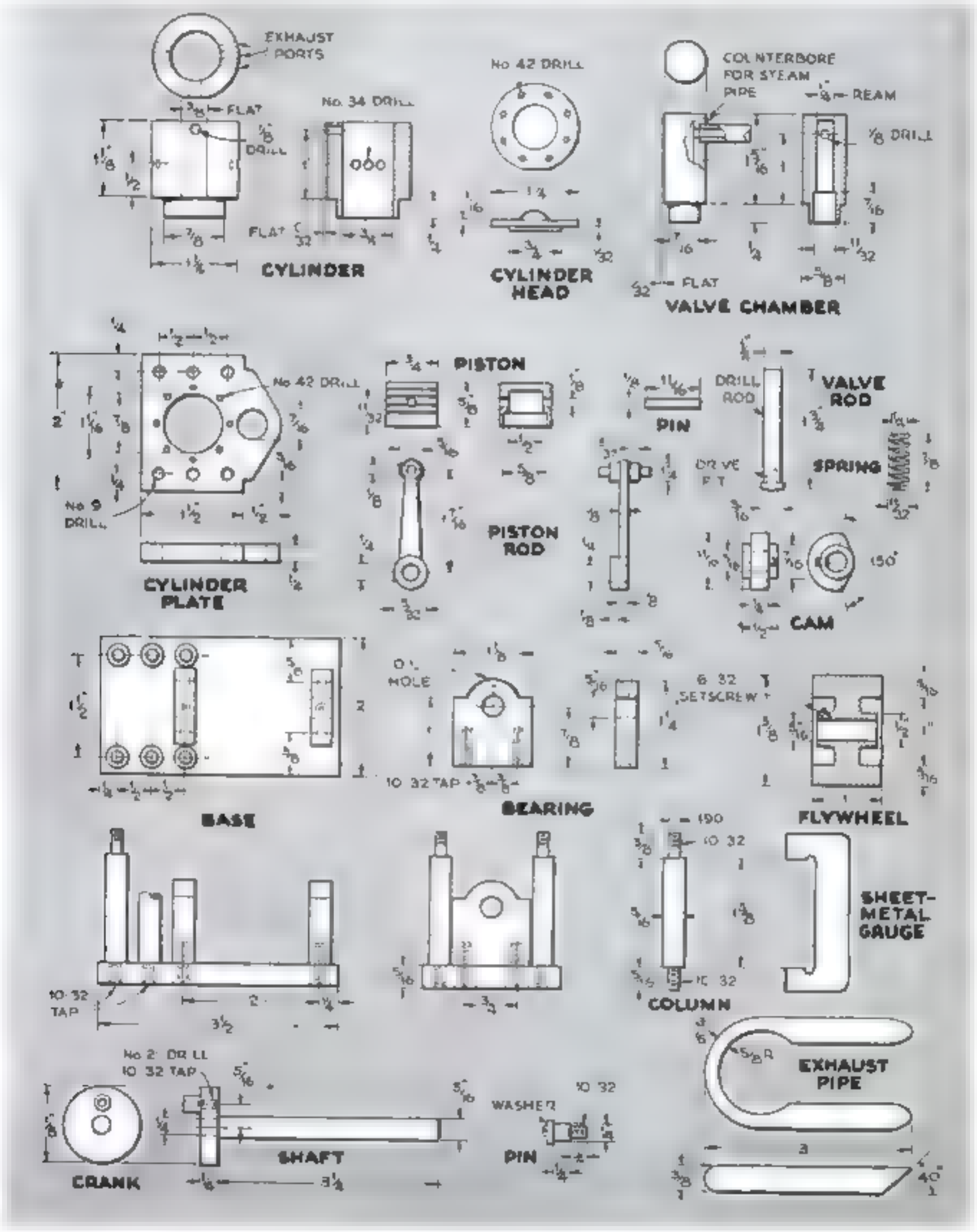
A heavy flywheel is required to carry the piston up on the return stroke. It can be chucked as shown in Fig. 17, turned to shape on one side, and drilled and reamed to a perfect fit for the crankshaft. Reverse it in the chuck to turn the other end to shape. Then mount it on a mandrel held between centers in the lathe and take a light cut across the face to insure its being perfectly concentric with the shaft. Drill the hub for a setscrew as shown in Fig. 18.

If stock of the thicknesses called for in the drawings is not available, and sub-

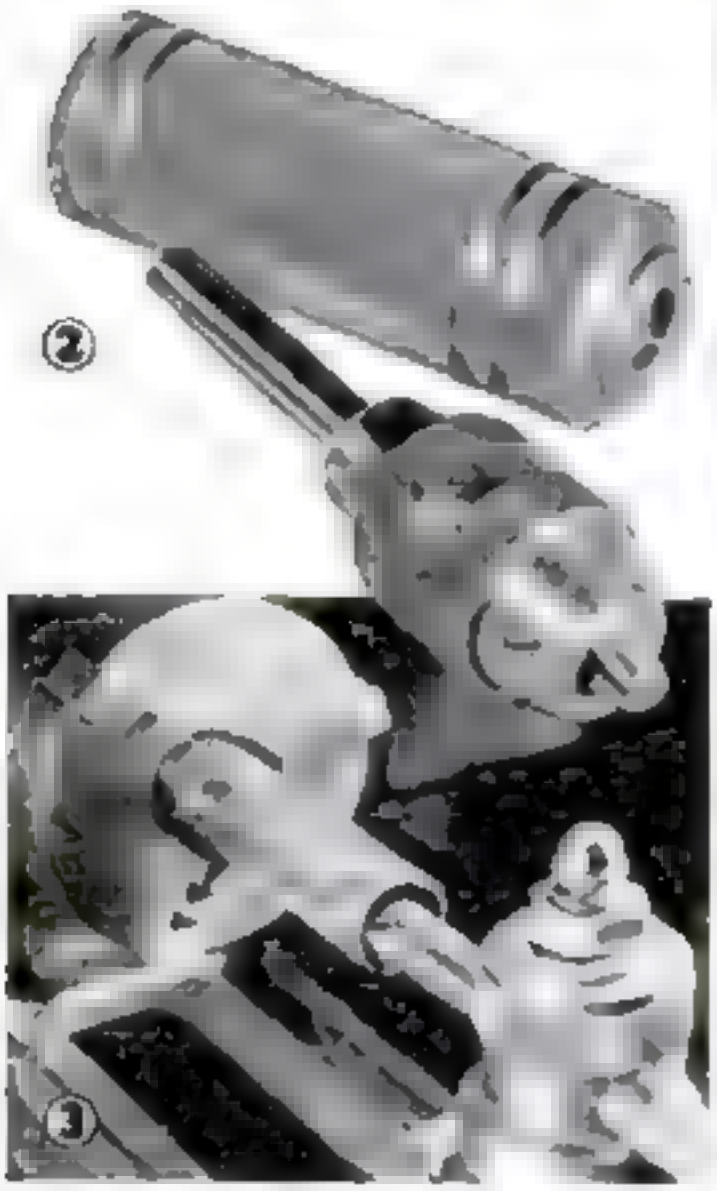
stitutions are made, it is best to make a trial assembly before the exhaust ports are drilled. The exact position of the top of the piston at bottom dead center can then be ascertained with a depth gauge, as shown in Fig. 19, and transferred to the outside of the cylinder. The ports should be drilled slightly above this point so that the piston uncovers them completely at its lowest point of travel.

As steam is worked through only one half of each revolution, all parts must work freely without binding at any point and without undue play. Fig. 20 shows the finished parts before assembly. The completed engine appears in Fig. 21.

Adjust the cam on the crankshaft so that the valve opens just as the piston reaches top dead center and remains open almost the full length of the down stroke. It should snap shut shortly before the exhaust ports are uncovered.

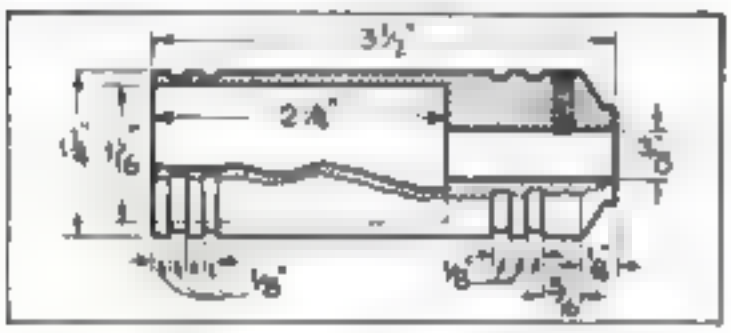


Tailstock Tap Holder Produces True Threads in Lathe Work



STARTING taps square in work chucked in the lathe is greatly simplified by the use of the sliding tap holder shown in Figs. 1 and 2 above. Slipped over the tailstock barrel, it is both advanced and held against turning by one hand. Its advantages over an ordinary tailstock chuck for this purpose are that it permits the tap to enter the hole as the threads draw it forward, and that it can be instantly released and allowed to revolve if the tap binds, thus preventing tap breakage. Tapping can therefore be done under power, although it is advisable to use a low, back-geared speed.

The chuck is of 3/16" capacity and has a straight shank that is held in the sleeve by a setscrew. Turn the sleeve from a bar of cold-rolled steel. Chuck this and support the free end with the tailstock center for the knurling; then bore it out, as in Fig. 3, to a close sliding fit over the tailstock barrel. Drill through with a ¼" drill and open the hole out to ⅜". Reverse the piece in the chuck, with cardboard under the jaws to protect the knurling, and face the end. Finally, drill a No. 29 hole and tap it 8-32 for the setscrew.—C. W. W.



TAP DRILL SIZES

[SHOP METHODS]

SMALL machine-screw taps are commonly designated by numbers instead of fractions of inches. The number before the hyphen represents the diameter of the tap or of a corresponding screw measured over the threads. No. 0 is the smallest, being .060" in diameter. The sizes increase by increments of .013", No. 1 being .073", No. 2, .086" and so forth. Between No. 8 and No. 10, and between No. 10 and No. 12, the increment is .026". Although this series runs up to No. 30, the number designation is little used above No. 12, being supplanted by actual sizes in fractions of an inch.

A second number designates the number of threads per inch. For example, a 2-56 screw is .086" in diameter and has 56 threads per inch.

The size of the tap drill is very important in obtaining a good thread. The following sizes of drills will produce approximately 75 percent of a full thread.

American National Coarse Thread Series

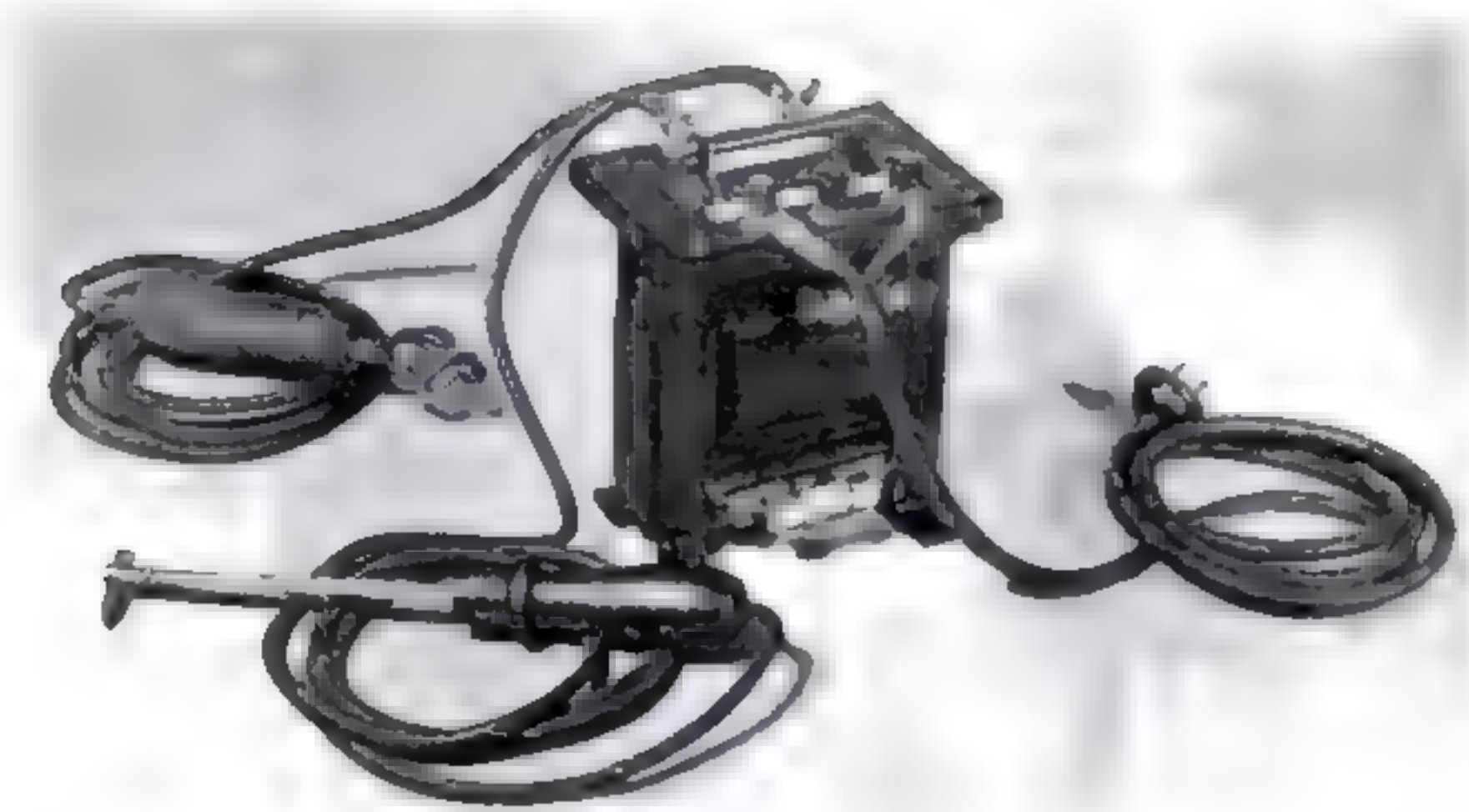
Number	Tap Drill	Number	Tap Drill
1-64	53	6-32	35
2-56	50	8-32	29
3-48	47	10-24	25
4-40	43	12-24	15
5-40	38		

American National Fine Thread Series

Number	Tap Drill	Number	Tap Drill
0-80	3/64"	5-44	37
1-72	53	6-40	33
2-64	49	8-36	29
3-56	45	10-32	21
4-48	42	12-28	14

Longer tap life, better threads, and easier cutting result if a cutting fluid is used. Animal lard oil or sulphurized cutting oil is generally used for tapping steel. Kerosene is satisfactory for aluminum. Brass and cast iron can usually be tapped dry.

POPULAR SCIENCE MONTHLY SHOP DATA



SALVAGED WIRE SERVES IN BUILDING THIS COMPACT

Soldering Transformer

By HAROLD P. STRAND

CAPABLE of many heavy soldering jobs, this small but efficient transformer delivers up to 110 amp. at about 5 volts for short periods. The heavy current raises a carbon electrode to white heat when it is held against the grounded work. No electric arc is formed as in welding, but the heat transferred is ample for soldering

The materials used in making the transformer require priorities if purchased new, but most home workshop mechanics can probably salvage what is needed from junked parts. The No. 16 wire for the primary can often be found in old motor fields, magnets, or solenoids. If one continuous length cannot be found to make up the 270 turns required, wind to the end of a layer and bring out a tap or splice which can be soldered and taped. The heavy flat wire for the secondary can be obtained from old automobile starting motors. If the wire is not as large in cross section as that specified, .321" by .1", lay two lengths together and wind them on in parallel, joining the ends in soldered lugs.

If no heavy flat wire can be obtained, an electrical shop or building salvage yard may be able to supply some old No. 8 rubber-covered wire such as is used for service conductors, submains, or motor wiring. Two pieces about 8' long will be required. Burn off all insulation, wind the clean wires with a layer of friction tape, and apply a coat of varnish. When this conductor is wound on over the primary much the same as the specified flat wire, it will serve about as well.

To get high efficiency from the small core cross section, the core material should be silicon transformer steel. Strips cut from the laminations of burned-out lighting transformers can be used. Other necessary items can generally be found here and there with little effort.

The first step is to cut the sheet metal into strips 1⅛" wide. Altogether, about 7½ lb. of steel will be required. Cut half the strips into 2⅜" lengths, and half into 4½" lengths, as in Fig. 1, and make two piles of strips of each length. Cut enough strips so that when they are piled and tightly compressed, each of the four piles will be 1½" high. Make all cuts perfectly square.

A wooden form is now needed to stack the core, as shown in Fig. 2. Wooden blocks nailed to the baseboard provide a slot in which a C-clamp is later fitted to hold the laminations. Start by placing two of the long strips and two of the short strips in the form as shown, butting the edges tightly together. In the next set, strips are laid in alternate positions so that they will cover the joints of the first. This procedure is followed throughout the stacking. When all

The white-hot carbon heats work enough to melt solder freely

the strips are in place, compress them tightly with a C-clamp so that the unit can be lifted out of the form.

After applying a layer of friction tape to the two sides of the core to pull them together as much as possible, the next step is to make four side irons, as in Fig. 3. Clamp two of them with 3/16" stove bolts to the end of the core opposite the C-clamp. Release the clamp and then carefully remove the laminations from this end. Lay aside the core, which should now look as it does in Fig. 3, and start work on the coil

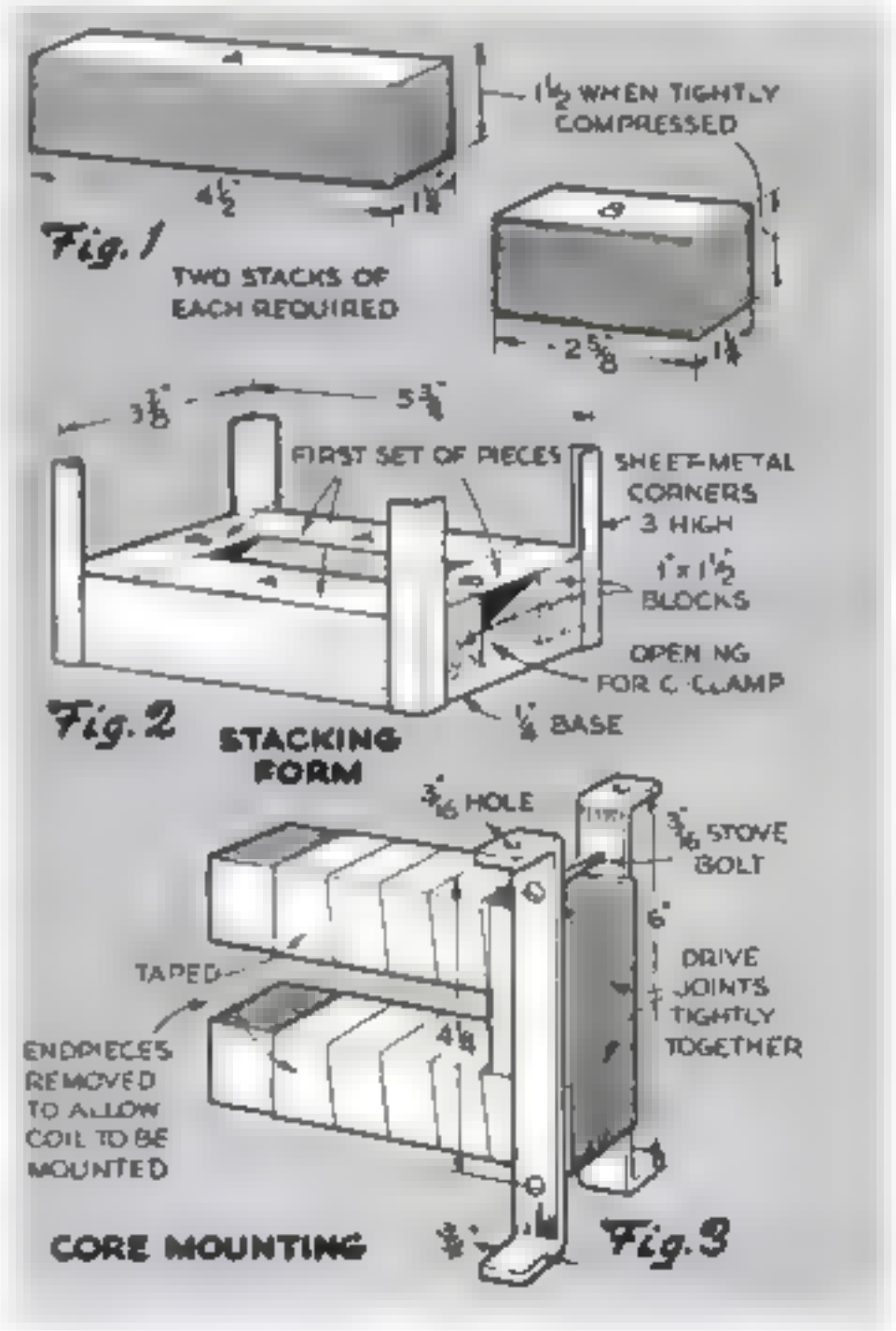
Another wooden form, shown in Fig. 4, will facilitate hand winding of the coil. Wrap three layers of varnished cambric, or a layer of thin fiber, around the form and secure it with cellulose tape. Insert the No. 16 wire through the hole in the side of the form and wind a layer with turns close together. A layer of brown paper is next wrapped around, a second layer of wire wound on, and the process continued until five layers have been applied. As No. 16 wire will wind about 45 turns to the 3" winding space, the winding so far will include 225 turns. At this point bring out a loop or tap, and wind on a sixth layer, making 270 turns in all.

Good insulation is required over the last layer. Several turns of varnished cambric will serve the purpose, or a layer of rubber tape followed by cellulose tape will do. Over this insulation, the heavy secondary winding is applied. Put on 12 turns, which may be in the form of six turns in each of two layers, depending on the width of the wire available. Bring the two ends to within ½" of each other, pulling them almost together with heavy cord, but being sure that they do not touch. Now take the form apart and remove the coil, which should look as it does in Fig. 5. Dip it in insulating varnish and allow it to dry very thoroughly in a hot place.

Place the coil on the open leg of the core and weave in the remaining laminations. Strips of fiber wedged between the coil and the core will keep the former tightly in place, and prevent a ground or short circuit. This fiber is best inserted just before the attachment of the last two side irons.

Next, measure the length required for the ends of the secondary winding to reach the wing-nut terminals. If the wire strip is wide enough, holes can be drilled in the ends for the terminal screws, but otherwise soldered copper lugs should be used. Before the final tightening of the side irons, drive all joints of the laminations solidly together and true up the core.

In Fig. 6 is shown the plan of the top panel, for which ⅜" plywood or a piece of



radio panel can be used. The two wing nuts are the low-voltage output, and the three insulated terminals are the 115-volt input. Four 3/16" machine screws hold the panel to the top ends of the side irons.

The plan of the wiring is shown in Fig. 8. To prevent overloading, a fuse should be connected in one side of the line. The holder for the fuse can be made by removing two of the clips from a 30-amp., 250-volt cartridge-type cutout. These are mounted on a ¾" strip of plastic with a thin piece of fiber under it to prevent grounding to the core, and the fuse block is secured with a single machine screw. The carbon holder and ground-clamp details are given in Fig. 7.

Using the input terminals plus-minus and No. 1, the output will be close to 5 volts; by changing the second wire to the No. 2 terminal, about 5.6 volts will result with an increase in amperage adequate for the heaviest work. Never connect the line to the No. 1 and No. 2 terminals. This might damage the winding and would probably blow the line fuses. The amount of heat can be regulated to some extent by the length of the carbon in the holder. Long carbons increase resistance and reduce heat.

In soldering, the carbon should be held behind or at the side of the work. This will help protect the eyes from the intense light, and will also keep the carbon from blackening the cleaned area. It takes only a few seconds for the work to heat up to a point where solder will flow. Small parts can be placed on a piece of sheet metal to which the ground clamp is attached, thus avoiding the grounding of each individual part. For such work, use the plus-minus and No. 1 posts, since this gives a smaller output than if the leads are attached to the plus-minus and No. 2 posts.

Keep the carbon in contact with the work during the soldering operation. The end of the carbon turns first to a red and then to an intensely white heat. As its heat increases, the electrical resistance of carbon becomes less, which is a characteristic opposite to that of most metallic conductors. A short carbon is best for heavy work, since it will pass the maximum current when fully heated.

Parts to be soldered should be thoroughly cleaned of all corrosion and dirt. Brass and copper are about the easiest of the common metals to solder. Whatever the metal, bulky and awkward jobs can be done more efficiently this way than with an iron.

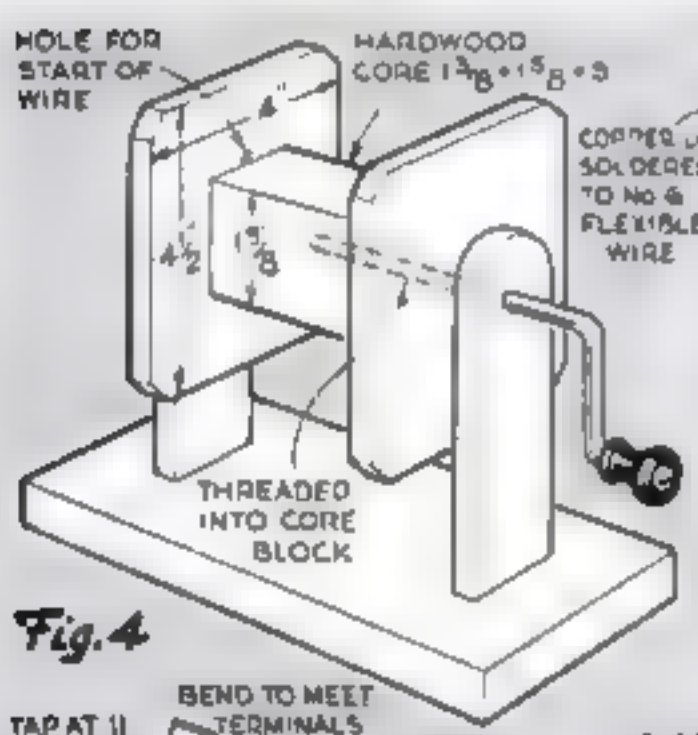


Fig. 4

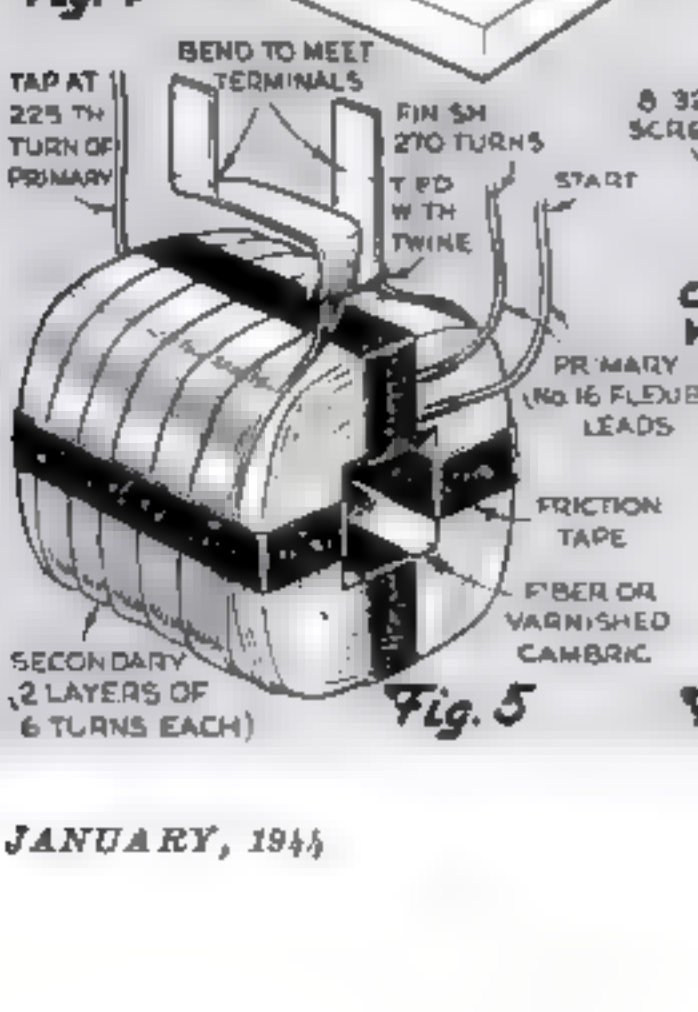


Fig. 5

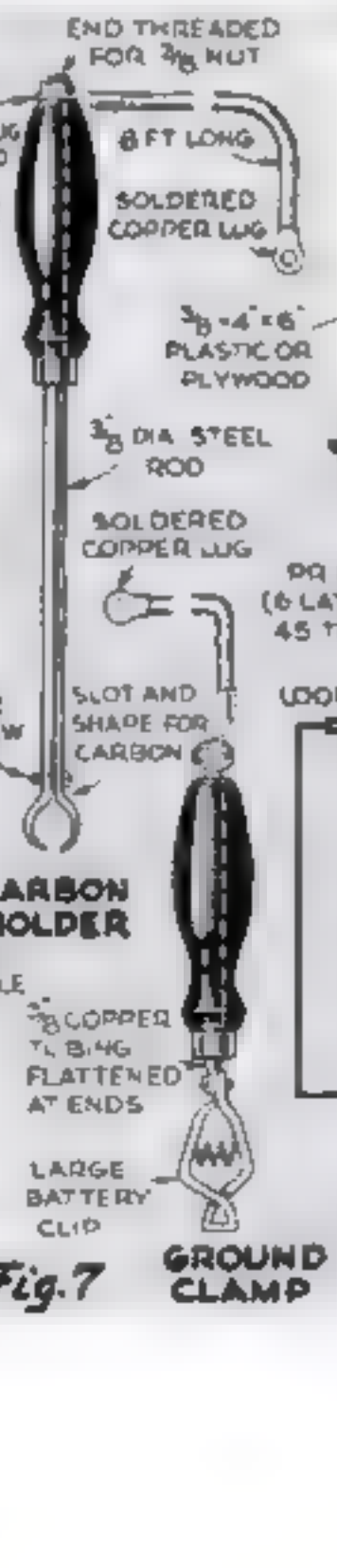


Fig. 7

Fig. 6

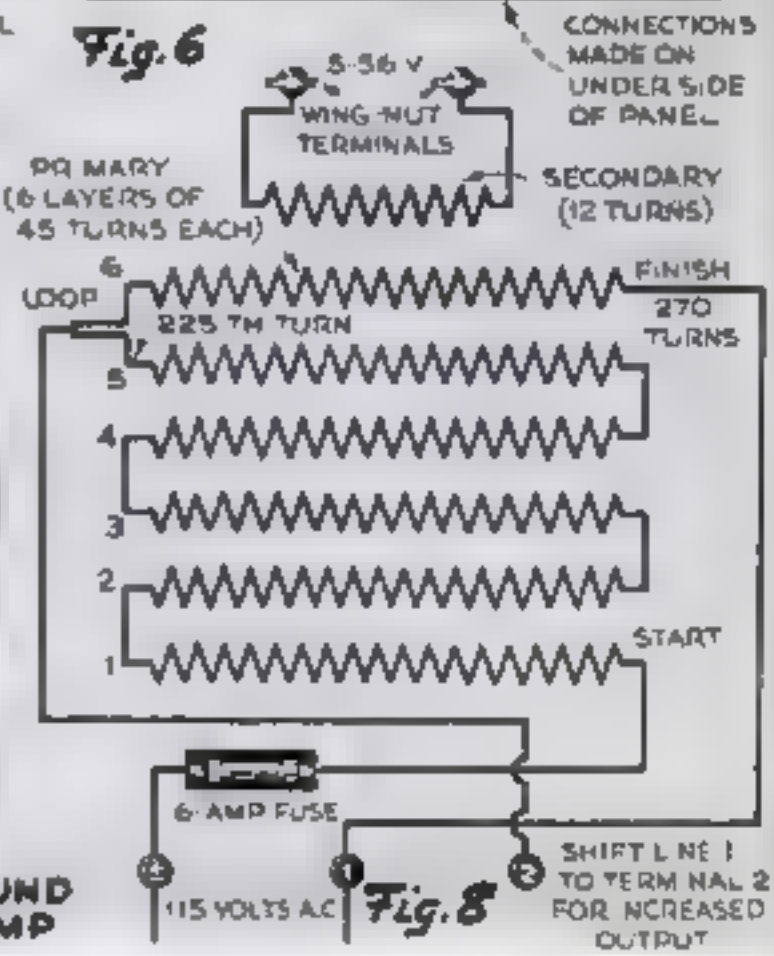


Fig. 8

radio ideas

CATHODE-RAY TUBES are used by one manufacturer to test carbon-element volume controls as they come off the production line. This method, said to be superior to the earphone and neon-bulb tests customarily made, uses in addition to the cathode tube a volume control of known characteristics. The unit to be checked is placed in a fixture where it is rotated to the same extent that the permanent control is also rotated. A varying pattern reproduced on the screen of the cathode-ray tube reveals such characteristics of the instrument as the resistance curve, effective rotation, and hop-off. It also detects any grounds or irregularities in the carbon element.

STANDARD FREQUENCIES and time signals are all that are broadcast by a powerful new station of the National Bureau of Standards. Casual dial-twisters who tune in on the transmitter, which broadcasts continuously on 5,000, 10,000, and 15,000 kilocycles, may be puzzled to hear only hums, whistles, and ticks. To radio engineers, military and naval technicians, scientists, and manufacturers of musical instruments, however, the station provides fixed standards of great value.

For example, one of the audio frequencies transmitted, 440 cycles per second, is the musical pitch corresponding to the A above middle C, and the broadcasts may help in settling some past disagreements as to the identity of tone A. The frequencies broadcast are reported to have an error of less than one part in 10,000,000.

A MOCK-UP of the radio rack used in United Air Lines passenger planes has been built for test purposes at the maintenance base of the company. The mock-up contains all radio equipment carried on the planes and is wired for actual operation. It is used by maintenance engineers in making studies of proposed changes in equipment, which are thus possible without holding a plane out of service.

CONDENSERS of the metal-enclosed tubular paper type are being used in many applications previously requiring molded mica units. The hermetically sealed condensers are also valuable where temperature-insulation resistance, voltage capacitance, and temperature capacitance are important. Their capacities range from .0001 to 1 mfd.

REPLACING HARD-TO-GET TUBES

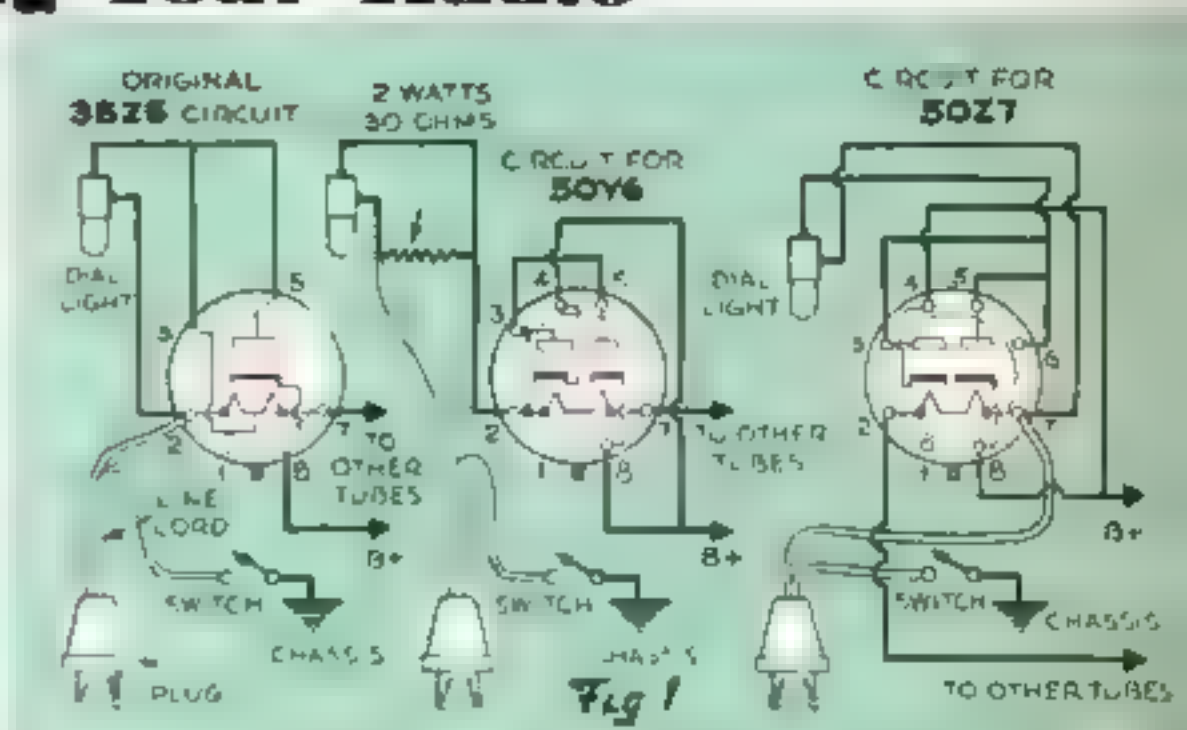
"Servicing Your Radio"

IF YOU can't obtain the correct replacement for a defective radio tube, your set needn't be laid up for the duration. Simple circuit changes may permit you to use other types of tubes. For example, the 35Z5 is a popular rectifier now difficult to procure. Fig. 1 shows how it can be replaced with a 50Z7 or a 50Y6. The difference in heater voltage between the original and its replacement will not materially alter set performance, it will in fact add to tube life. When neither of these replacements is available, an older tube such as the 25Z5 may serve, while if a 35L6 or 50L6 power tube burns out, it can be replaced with a 43, a common pentode. But since the heater voltages of these substitutes differ from those of newer tubes, some changes in heater wiring are necessary.

Let's suppose you have an A.C.-D.C. superheterodyne with a 12SA7 converter, a 12SK7 I.F. amplifier, a 12SQ7 diode detector, a 35L6 or a 50L6 pentode, and a 35Z5 rectifier. If the set is to be adapted for a 43 pentode and a 25Z5 rectifier, make the changes indicated in Fig. 2. A new line cord with a 125-ohm resistor is installed, and the heaters of the 12SA7 and the 12SK7 are rewired in parallel instead of in series. An 85-ohm, 4-watt resistor is placed across the heater of the 12SQ7. Two 6-prong sockets are substituted for the 8-prong sockets.

Battery-operated tubes may also be pressed into service. Suppose that a receiver has a 6A8 converter, a 6K7 I.F. amplifier, a 6Q7 or a 6J7 detector, a 25L6 pentode, and a 25Z6 rectifier—and that all but the 25L6 and the 6Q7 become defective. A 25Z5 is used for the rectifier, while such battery tubes as a 1A7 or 1A6 and a 1N5 or 1D5 replace the 6A8 and 6K7, respectively. The hookup is shown in Fig 3.

If the 25Z6 did not burn out, the other substitutions can still be made, provided the 25Z6 socket is rewired as shown. By using the proper line-cord resistor, any combination of A.C.-D.C. tubes with 6.3-volt, .3-amp. heaters can be used in circuit *A*. Any combination of battery tubes can be used in circuit *B* by changing the value of the 3,000-ohm resistor.



Amplifier Circuits and

FIRST STEPS IN ELECTRONICS

A SINGLE pentode can readily amplify a feeble input signal 350 times, but what if we require an output strength 350,000 or 3,500,000 times that of the original impulse? An example of this is the home radio. A distant station may generate in the antenna a signal to be measured only in millionths of a volt, whereas the loudspeaker may require several volts. Here an amplification of several million is needed. It is obtained by using tubes in cascade.

If the output of one tube is fed into the grid of the next, the amplification of the two tubes is not the sum of their single amplification factors (a value called the *mu* of the tube) but the product. Thus if a high-mu triode amplifies 50 times, two in cascade will amplify 50 times 50, or 2,500 times.

But when we begin to feed the plate current of one tube into the grid circuit of another, we run into trouble. Figure 1, for example, shows a simple hookup of two triodes. This won't work at all. The second grid, being connected directly to the first plate, is at about the same potential as its own plate, which is connected to the same plate supply. The result is that the second tube won't react to small changes in grid voltage and will not amplify at all. In fact, the high grid voltage will attract so many electrons toward the plate that the tube will probably burn out.

As shown in Fig. 2a, this fault can be overcome by inserting a grid bias battery of about the same voltage as the plate supply. The grid is at approximately the same potential as the cathode, and the tube will react to small voltage variations produced on this grid by the output of the first tube.

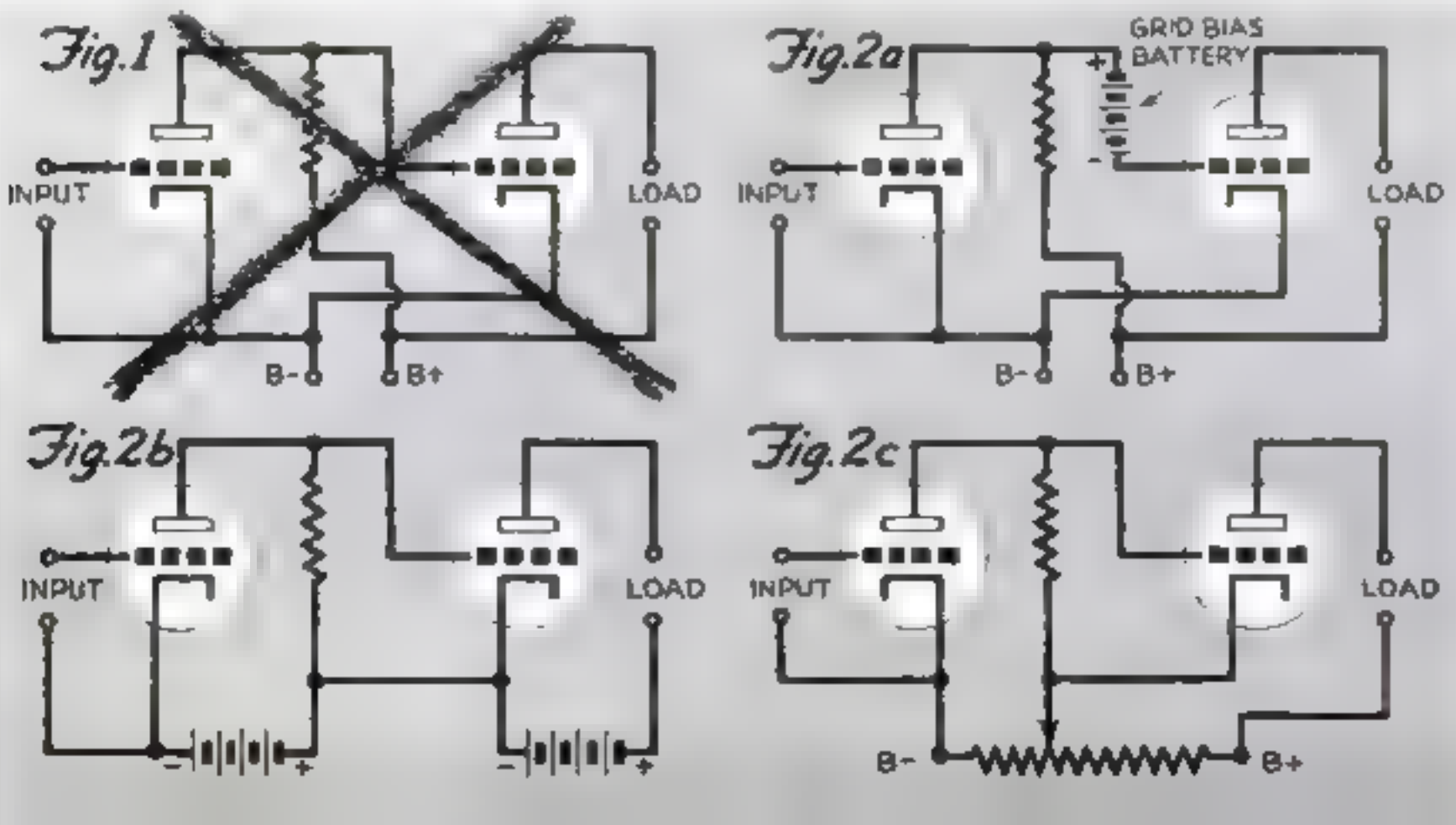
A similar result is achieved in Fig. 2b by using a separate plate supply for each tube, and in Fig. 2c by dividing the potential of a single large plate-voltage supply across a resistor

These two circuits are frequently used as so-called D.C. (direct-current) amplifiers. They will amplify a variation in D.C. or the voltage of D.C., and will faithfully reproduce the wave form of a signal. Medical research makes use of such amplifiers. Figure 3 shows some of the odd wave forms they will follow and reproduce.

But for other purposes, including radio, these hookups are unsatisfactory. One reason is that each tube requires its own plate supply (or two tubes require a single one twice as large, if a voltage divider is used as in Fig. 2c.) If screen grids and suppressors are to be connected, still more power supplies may be needed.

Even more serious is the fact that these circuits amplify the total input current as well as any variation in it. Suppose the average input is 1 milliampere and varies .001 milliampere. To read that variation on a meter, we may wish to amplify it to one of 10 milliamperes, or 10,000 times. But a D.C. amplifier, in stepping up the variation to this extent, must also amplify the 1-milliampere input current, which will become 10,000 milliamperes, or 10 amperes—a current only heavy-duty transmission tubes could handle. Figure 4 illustrates this.

The answer is, of course, to amplify only the variations and not the D.C. component. Figure 5 shows how this can be done with transformer coupling. A transformer can-



How They Work

By John W. Campbell, Jr.

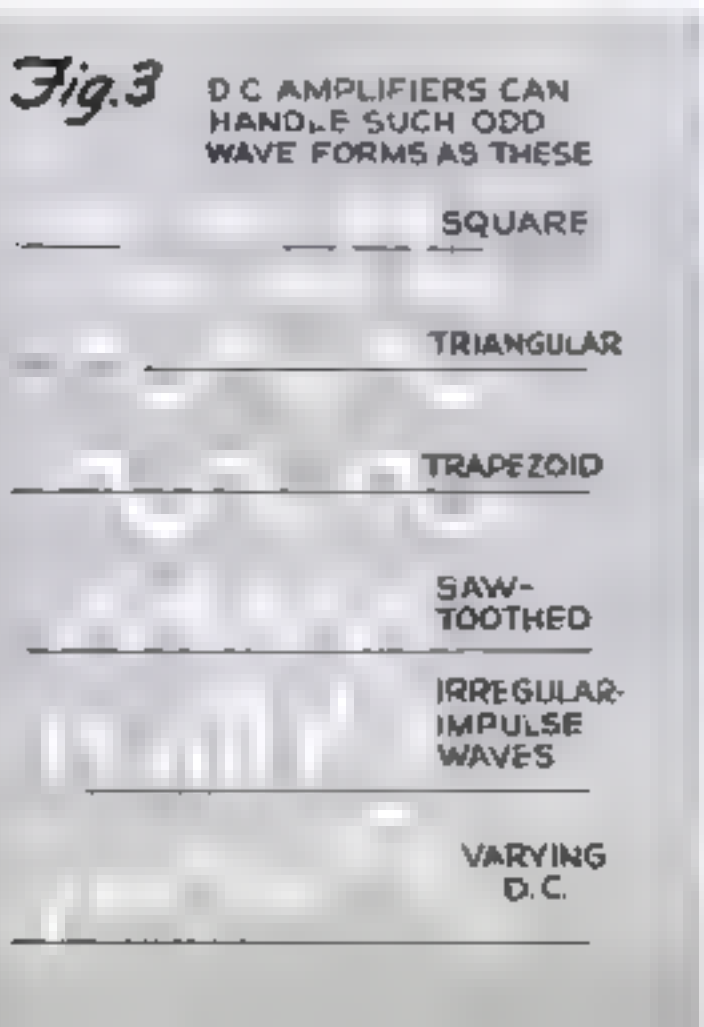
not pass direct current; its secondary responds only to *changes* in the primary current. The D.C. component flows through the primary from the plate to the B supply. Only *variations* in the plate current (caused by the input signal on the first grid) are impressed on the secondary and so carried on to the second grid.

A second way of passing only current variations on to the second grid is shown in Fig. 6. Several previously neglected features have been included. A variable resistor or potentiometer R1 is included as a volume control; the whole input voltage is impressed across this and the desired fraction applied to the first grid by adjusting the sliding contact. The plate current flows through the plate resistor R5, and coupling is through the blocking condenser C3. This blocks the D.C. plate supply from the grid of the second tube, but passes the varying component freely, because a condenser in effect "conducts" A.C. In an audio-frequency amplifier, this condenser would be one of .004 to .01-mfd. capacity.

Since it is desirable to have the grid negative to the cathode, we can either add a grid bias battery or make the cathode slightly positive to the ground. The latter effect is achieved by adding the bias resistors R2 and R3. The plate current flowing through them causes a voltage drop across each of these resistors, so that the cathode has a few less electrons on it—is slightly more positive—that if it were connected directly to ground. The grid, grounded through R1 in the first tube and through R4 in the second, is therefore negative with respect to the cathode.

However, to get the full voltage of the signal on the cathode, we don't want it to fight its way through R2 and R3. We provide an alternative way for it through the by-pass condensers C1 and C2. Being A.C., the signal passes these freely. For audio frequencies, these condensers are from 1 to 10 mfd, and 25-volt electrolytic condensers are often used. [CONTINUED]

Fig. 3 D C AMPLIFIERS CAN HANDLE SUCH ODD WAVE FORMS AS THESE



Microphone impulses are amplified by this unit before entering the transmitting tubes of international short-wave station WGEO

Photo courtesy of General Electric

Fig. 4

A D.C. AMPLIFIER AMPLIFIES BOTH THE ORIGINAL CURRENT AND THE CURRENT VARIATIONS

Fig. 5

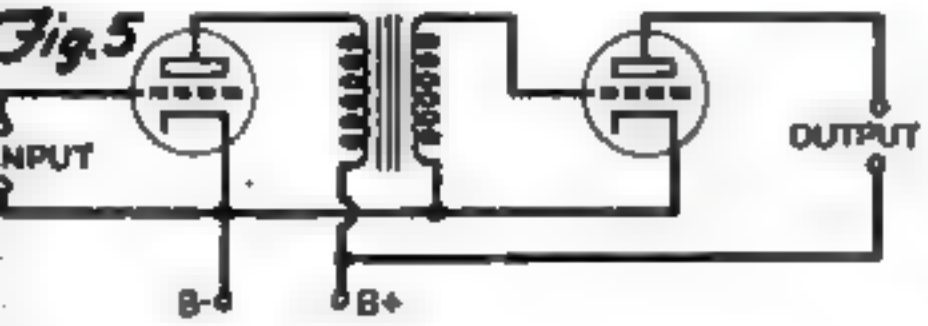
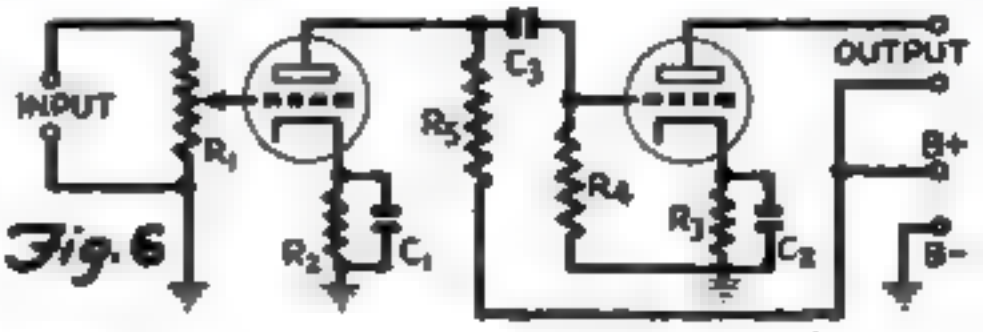


Fig. 6



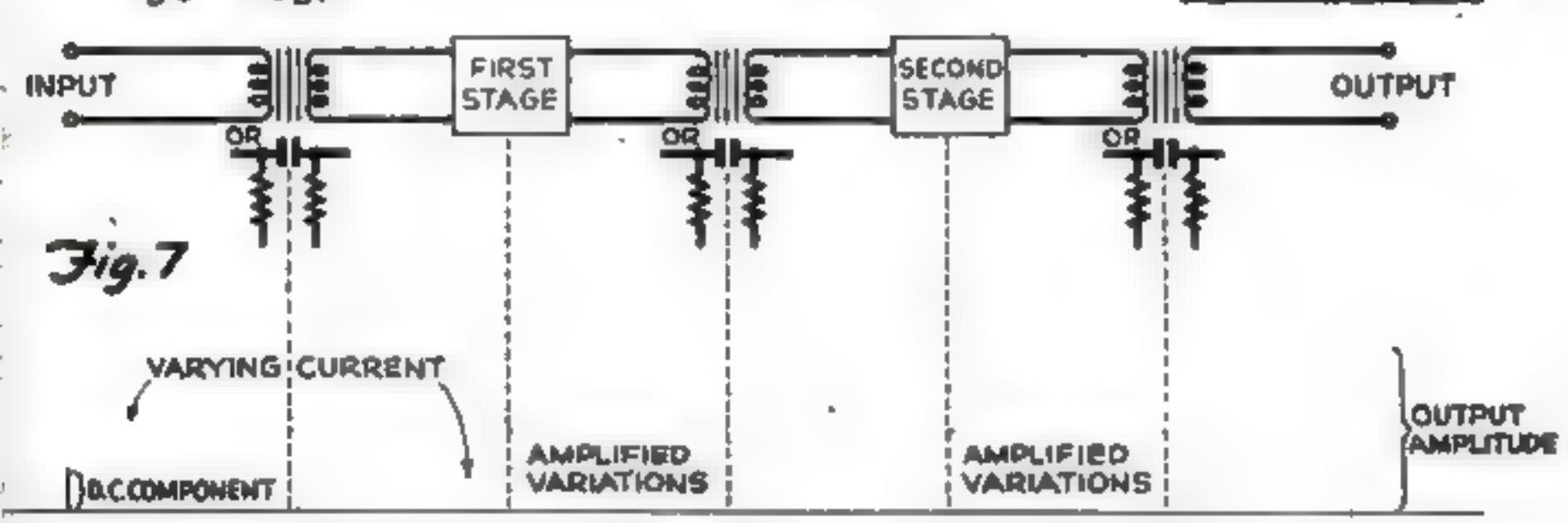


Fig. 7

IN AN A.C. AMPLIFIER, TRANSFORMER OR RESISTANCE COUPLING PASSES ON ONLY THE VARYING COMPONENT

We need the resistor R4 because, as the condenser C3 cannot pass D.C., the grid would be insulated from ground without it. Stray electrons from the cathode would soon charge the grid so strongly negative as to block the tube completely.

Still another way of connecting tubes in cascade is by impedance coupling. A choke coil (an inductance) is substituted for the load resistor R5 in Fig. 6. This passes a constant plate current unhindered, but variations generated in it by the signal impressed on the grid will be resisted by the inductance and will result in an A.C. voltage across it, which in turn will be impressed upon the coupling condenser C3. This coupling method finds little application in A.F. amplifiers, because a small resistor can do the same work as a larger, more expensive choke coil. At radio frequencies, choke coils are very small and offer advantages over resistors.

The decoupling resistors and condensers (Rd and Cd) in the amplifier circuit on the facing page keep plate-current fluctuations of the output tube from feeding back into the plate circuit of the first tube through the common plate-supply connection. Were they to reach this tube, they would cause fluctuations in the first blocking condenser and so affect the grid of the second tube. This tube, after amplifying them, would pass them to the third tube, from which they would return further amplified to the first one—and how the amplifier would squeal!

Instead, they go to ground through the condensers Cd, which to them represent a closed circuit, while the D.C. plate current is impressed on the plates through the resistors. For audio frequencies, Cd is usually an electrolytic condenser rated at 250 to 400 volts and having a capacity of 4 to 8 mfd.

In building an amplifier, remember that audio-frequency currents can pass, by induction, from one wire to another. That includes 60-cycle current. Keep heater leads away from grid leads, preferably twisted together in a corner channel of a metal chassis. Don't let plate-circuit leads pass near the grid leads of a preceding tube. It's wise to mount plate resistors right on the tube sockets, and to attach the decoupling

condensers to them there, cutting the leads off to ¼" or less.

The result of jamming parts together may look anything but neat, but the real problem is one of electrical neatness. Keep every lead as short as you can—short leads mean smaller "aerials" from which currents can jump by induction. Keep input and output leads as far apart as the chassis will permit. A straight-line layout is good. So is building the power pack in a separate unit.

If despite all these precautions your amplifier still hums or whistles, hitch insulated test leads to a .5-mfd or larger paper condenser and touch it across the various by-pass condensers. Keep your fingers out—use long, stiff, well-insulated wire probes. If no improvement is apparent, try hooking an 8-mfd, high-voltage electrolytic condenser across the decoupling and cathode by-pass circuits. In testing, be sure that you always connect such an electrolytic condenser with due respect for polarity.

Since these tests must be made with power on, extreme caution is indicated. Remember that the high-voltage current present is capable of delivering a serious shock. Take care to avoid contact with live wires.

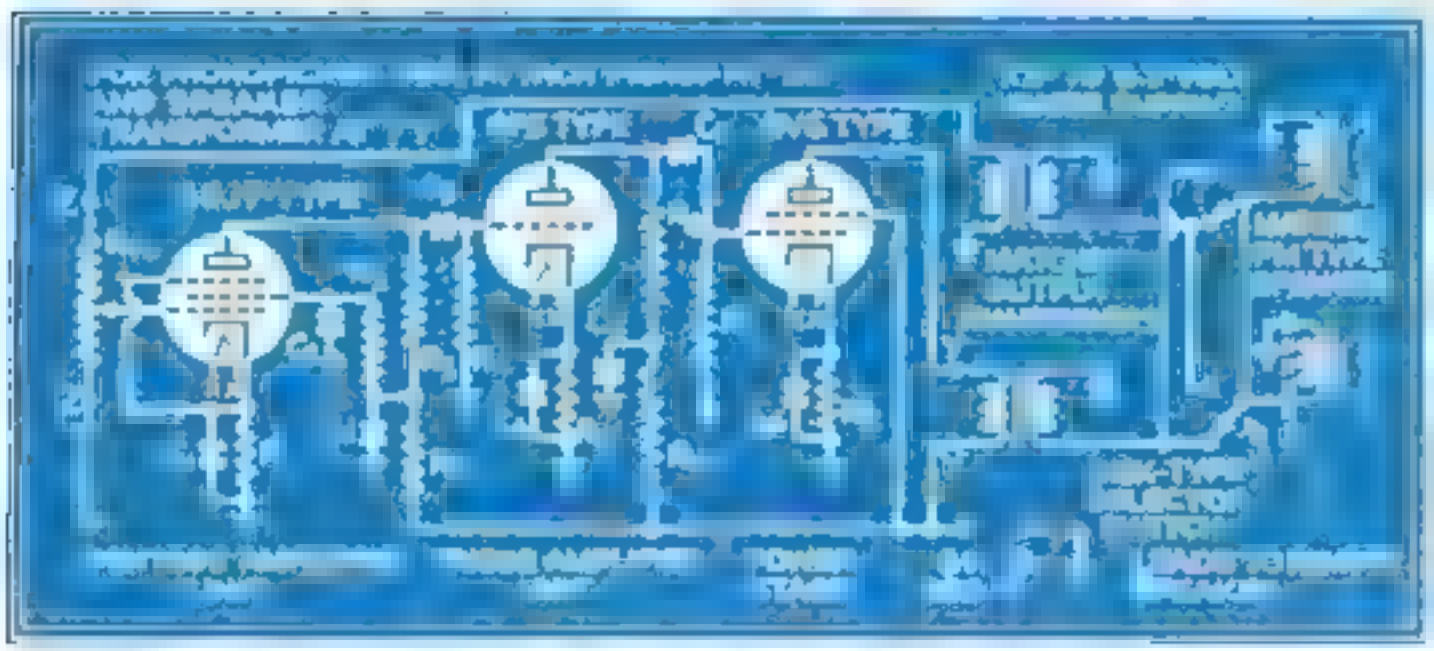
High-Gain Amplifier Can Be Used As Two-Way Communicator

THIS resistance-coupled audio amplifier will readily step up the output of a radio detector stage or phonograph pickup to loudspeaker volume. With two identical permanent-magnet speakers, it can be used as a room-to-room communicator, the speakers acting alternately as microphones. Water or steam pipes will serve as one lead to the remote speaker. The switch is of the ganged double-pole, double-throw type and is located at the amplifier. It switches the input to either speaker. A miniature D.P.D.T. switch cannot be used, however, as the input and output leads cannot be brought so close together. The outfit will howl if both speakers are in the same room, as when testing, because of acoustic coupling between them.

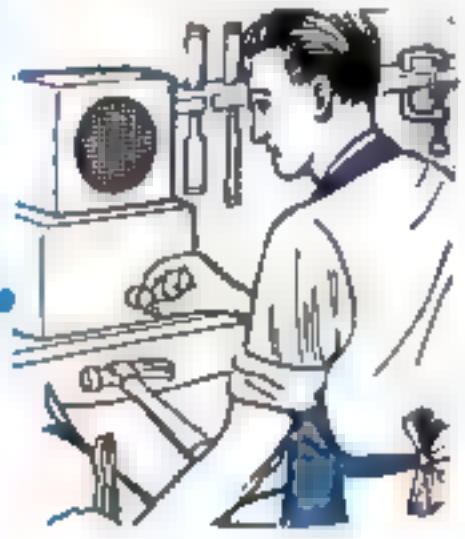
A 6SJ7 pentode, 6F5 triode, and 6V6 beam power tube were used in the original. Triodes alone, or other tubes of the same types, may be used, but other values of condensers and resistors may be needed. The following are right for the tubes specified:

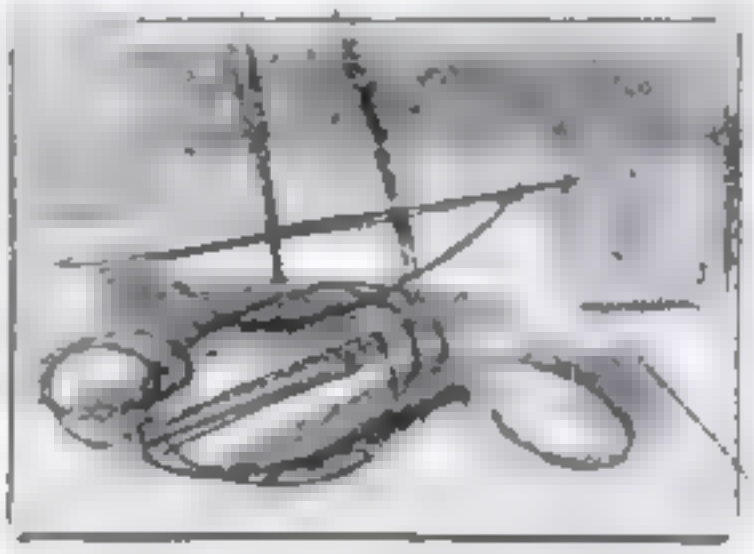
Rvc, 500,000-ohm potentiometer; R1, 1,060 ohms; R2, 1,000,000 ohms; R3, 250,000 ohms; R4, 500,000 ohms; R5, 4,000 ohms; R6, 250,000 ohms; R7, 500,000 ohms; R8, 325 ohms; C1, C4, C6, 8 to 10-mfd, 25-volt electrolytics; C2, .1 mfd., 400 volts; C3, .005 mfd.; C5, .006 mfd.; Cd, 8-mfd., 250-volt electrolytic; Rd, 30,000 ohms.

"Supper in five minutes," can be announced by the lady of the house to her husband downstairs without a skip of the beater. At left, the amplifier unit



"Coming right up!" is his answer. A switch reverses the connections





STOP, LOOK, AND THINK
BEFORE YOU SHOOT

Planning Your Photos

GIVES BETTER PICTURES FROM LESS FILM

By KONRAD CRAMER

Director, Woodstock School of Photography

A PLANNED approach to photography simply means correcting your mistakes before you make them. We have learned through war shortages that we can ill afford to make wasteful errors. Such mistakes and oversights often ruin what might be an excellent picture. Who among us has not at times made a shot that would have been a "honey" if that big telephone pole were not growing out of cousin Harry's head? Errors like these are costly at any time; they are a keen disappointment when you have no opportunity for a retake—and yet they can be easily avoided.

Remember, few corrections can be made *after* the shutter has been released, so let us adopt the slogan "stop, look, and think" *before* we push the button. The major cause of the errors committed by the average snapshooter is unnecessary haste.

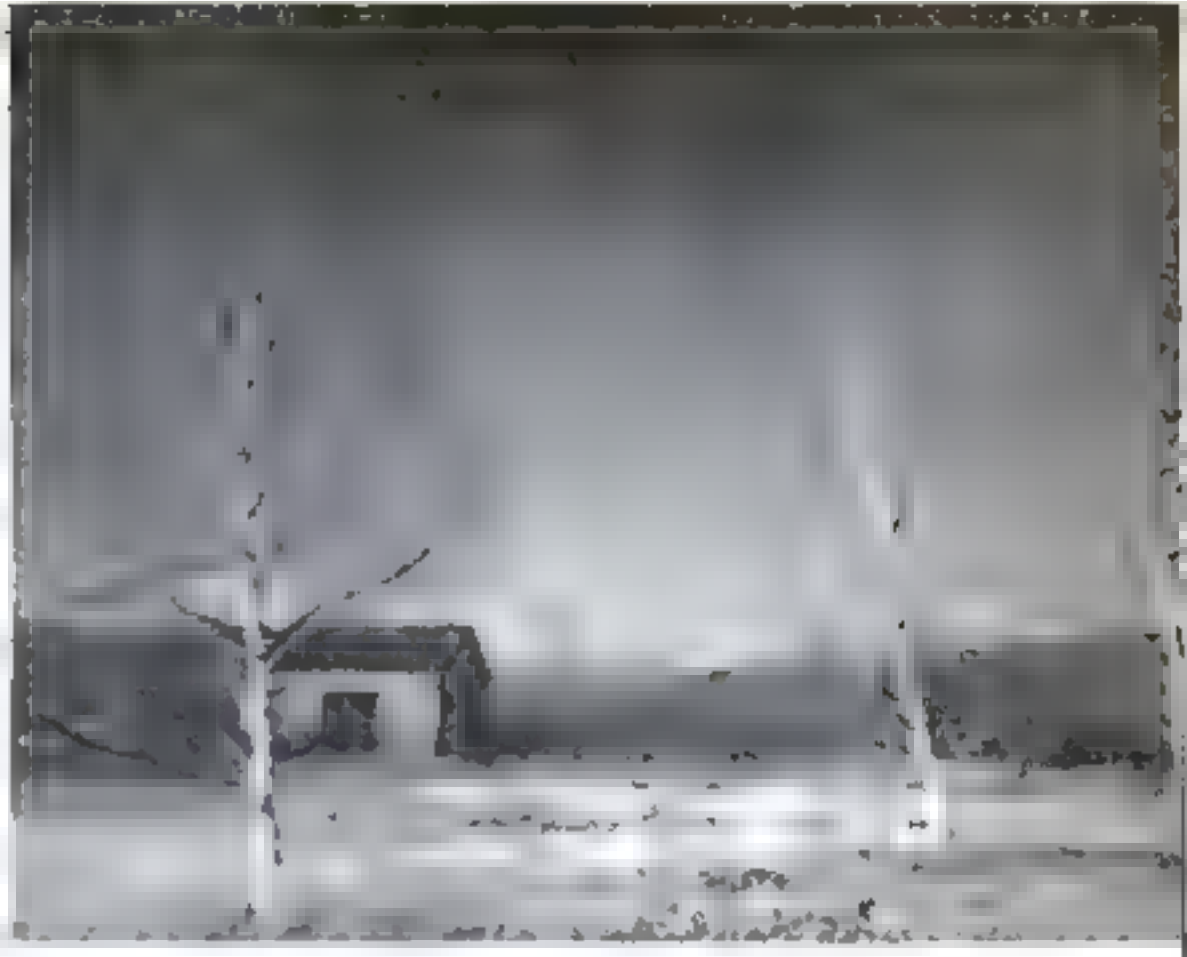
Confronted with what he thinks is good picture material, the average amateur will unlimber his camera and bang away in the best Western frontier style (only he rarely scores a hit). Such speedy trigger action is only justified when the movement of his subject matter demands it. Using a tripod

Sketching in the subjects before you snap your shutter, as illustrated at the top of this page, gives you better composition and a good picture

Photography

whenever possible is a great aid to picture planning

The successful artist and photographer actually sees the picture or the photograph he is going to make before he touches paint to canvas or clicks the shutter of his camera. A great help in this visualizing is the habit the professional has of making little plans or sketches for his future pictures. These sketches are really working plans and do not require any skill in drawing. Even the tools for such



LOW

There is a sense of loftiness and height in the picture above. It comes from the low horizon

MEDIUM

Where you place the horizon of your picture is most important. A medium horizon like that at the left is usually a humdrum choice

HIGH

Distance is the illusion given by a high horizon. Below, it permits a vast stretch of foreground snow

drawings can be almost anything. A pointed stick scratching lines in the sand is enough to help you plan the layout of your budding masterpiece.

I recommend to my students that they always carry with them a small piece of soft charcoal about 2" long. Such soft, broad drawing material is preferable to the fine point of a pen or pencil because it will not tempt you to make a regular drawing of what is before you. Remember, the idea is *not* to draw the birch trees in front of you, but to make a mark which shows

NO HORIZON. With the horizon outside the picture area, a variety of unusual arrangements is possible. Here the horizon is over the picture; in a photo of airplanes, it might be under

the place where the camera lens is to draw them for you in the picture space.

This is the way to begin. On any old piece of paper, or in the sand or snow, draw a rectangle of the same proportion as your film. (I carry a few pieces of wrapping paper cut to film dimensions in my camera case.) The first decision you will have to make is whether your picture material looks best in a horizontal or vertical arrangement —and it is an important decision. A peaceful landscape with low, rolling hills usually fits better in a horizontal frame, while the tall buildings of New York seem to cry out for an upright picture space.

There is another most important aspect of picture planning: deciding where best to place the horizon in your picture. In the picture at the top of the preceding page the horizon is placed very low, conveying an illusion of height and loftiness. The medium horizon in the picture below it seems to be the least exciting choice, and yet 90 percent of all amateur snapshots generally display this tiresome choice. In the picture at the bottom of the page a very high horizon gives an illusion of distance, while in that at the top of this page the horizon is placed outside the picture space—a practice that permits all kinds of unusual arrangements.

Pick up a magazine and look over the pictures, studying the various effects achieved by the judicious placing of the horizon. Not only landscapes and seascapes have horizons, but even still lifes and portraits often exist in some relation to a horizon. After you have determined what we might call the space relation, it only remains to distribute the rest of the major picture elements within this space. To do this, take your charcoal, and inside of the four lines that will confine your picture make an appropriate mark at the spot you think it would be best to place, say, the barn in the top or bottom photo on page 171. Then see how the rest of the picture elements fit into your picture space. Keep in mind that, while it might be troublesome to move the barn itself, it is no trouble at all for the serious photographer to move his camera.

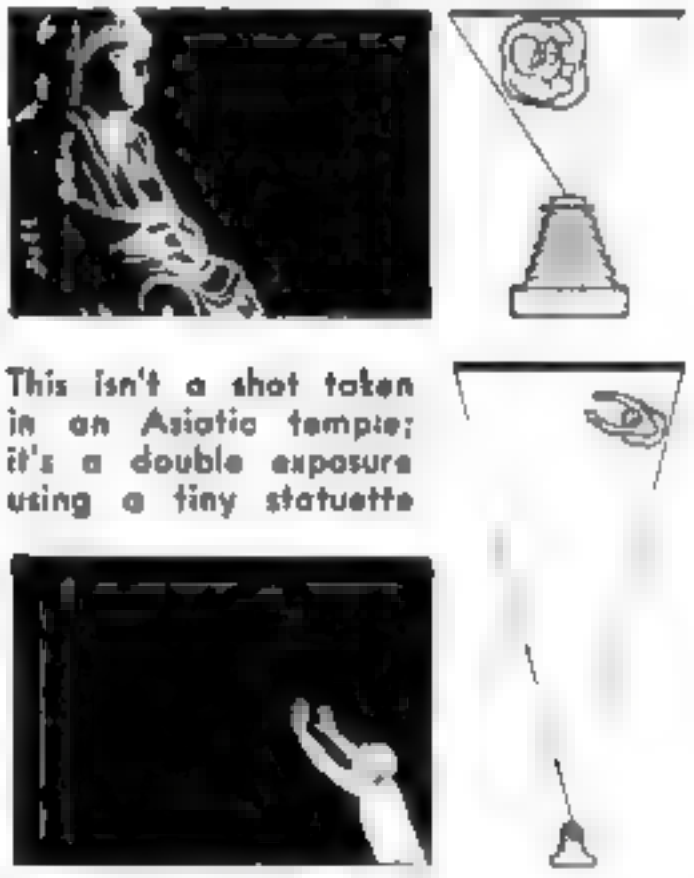
Too many pictures are taken from the spot where the idea of a picture first occurred. This is one of the cardinal sins of picture making. Don't be satisfied. Poke around, watch the picture change in your finder as you move a few feet to the right

or left, or forward or backward. While the photographer has not quite the same freedom of changing things in front of him as the painter has, he can nevertheless achieve innumerable variations of arrangements by such means as camera position and angle and by lens selection. A wide-angle lens differs drastically from an ordinary lens in the way it records your chosen scene.

One more admonition. If, after having planned your future masterpiece, you find that it holds little promise of success, put your camera away and congratulate yourself for not having wasted time and material. This method of picture planning has its greatest value in keeping you from shooting blindly and haphazardly with the idle hope that, as long as you make enough photographs, one or two of them ought to be all right.

And most valuable of all, in carefully planning your picture approach, you teach yourself to see pictures before you take them. There is a tremendous difference between just looking at things and seeing them. Developing your visual memory is one of the best investments you can make. You may have looked at the Grand Canyon, but can you see it again in your mind's eye any time you want to? If you can, you have a faculty which should be a great help to you in taking pictures that satisfy.

Toys and Statuettes Form Impressive Props for Trick Shots



This isn't a shot taken in an Asiatic temple; it's a double exposure using a tiny statuette

OFTEN, when you look at small toys and statuettes, you can imagine many interesting picture possibilities, if only these miniatures were of huge, majestic proportions. It is a simple matter, though, to magnify their size and use them as props, adding greatly reduced human figures to the composition for emphasis.

For this stunt, a black background is necessary to prevent registering of an exposure on the unused portions of the film. Set up the miniature prop in front of this background and shoot a giant close-up, framing it in such a manner that sufficient portions of the film are left unexposed by the black background.

Next, trace the image of the prop on the ground glass in order to mark the section of the picture on which it will appear; then, moving the camera back, focus on a human model or models so placed that the unused parts of the film will be filled to complete the composition. When this second exposure is made, the result will be human figures in a picture with a gigantic statue or toy. Be sure that the black background is large enough to cover the entire field when the camera is moved back.—LOUIS HOCHMAN.

Heating Element Used as Wire in Photographic Developer

IF YOU need a piece of wire inside a developing tank, tray, or other photographic equipment, take it from an old toaster, heater, or flatiron. Wire used as the heating element in these appliances is nichrome—a nickel and chromium alloy, as resistant to photographic solutions as silver wire and far stronger. Typical darkroom uses include repairing broken plastic parts and linking together sections of cut film.—J. W. C.

MILLIONTH-OF-A-SECOND

Made with Pencil-Size

SPEED photography chalks up another fabulous record with exposures now being made at a millionth of a second. This is possible with a new mercury flash lamp that has a useful life of but one second, yet in that brief span is good for 1,000,000 exposures, far more than the amateur photographer will make in a lifetime.

Using the mercury lamp, engineers at the General Electric Company, who developed the flash-lamp device, made the photographs on this page. That at the left shows what happens as a stream of heated air is drawn through an electric fan revolving at a speed of 1,800 r.p.m. Below are three views of an arrow leaving a bow at 400′ per second, and one of the first jet of water from a faucet turned on full force.

The mercury lamp, no thicker than a pencil, is the source of high-intensity light. It is housed in a reflector lamp resembling a small auto headlight and can be operated manually by push button or automatically by electrical contacts or a phototube and preamplifier. Illumination is sufficiently intense over 20 sq. ft. for photographing the fastest moving objects.

Using household current, the device rectifies it to D.C. in an electron tube and charges a capacitor that in three seconds accumulates enough power to operate the lamp at full flash intensity. The current, at approximately 2,000 volts and 2,000 amp., reaches a maximum of some 4,000,000 watts, lighting the lamp for a millionth of a second. All equipment fits in a readily portable box and weighs less than 20 lb.

Though the archer is unaware of it, there is an appreciable gap between bow and arrow at the start of a flight, as these millionth-of-a-second photos show. This throws light on the ancient archer's paradox, that phenomenon by which an arrow flies straight despite its initial slant

Water rushing from a faucet turned on full force — taken at the instant the jet breaks

PICTURES

Mercury Flash Lamp

The high-speed mercury lamp, above, is scarcely longer than a kitchen match, but it consumes some 4 000 000 watts during its brief flash. Left, S. Lawrence Bellinger, one of the engineers who helped develop it, inspects the compact electronic control

Professional Pictures Teach Amateurs Good Photo Technique

THE techniques used by professionals when they are "covering" a photographic assignment for a newspaper or a magazine can provide valuable lessons for the amateur. The subject matter, camera angle, and composition of the two photos at right, showing a mounted U. S. Coast Guard beach patrol and its Army-loaned horses somewhere on the coast of Washington, have been used to attain the best results both photographically and from a journalistic viewpoint.

A wise choice of camera angle is demonstrated in the first photo. It shows to full advantage the trailer, the horses, and the men in action. An amateur would probably have photographed the trailer from a lower viewpoint, in which case only the horses' heads would have been visible along with the one man in the foreground and part of the Coast Guardsman in the cart. The beach scene continues the story the first picture began to tell, but in addition to this, it is pictorially excellent.

What this news photographer has done can be applied to any picture-taking problem. Often it may mean the difference between just another snapshot and a really valuable photograph, or series of photographs, telling vividly and artistically an interesting story. A careful study of the subject at various angles, together with particular attention to composition, will go far toward achieving these results.

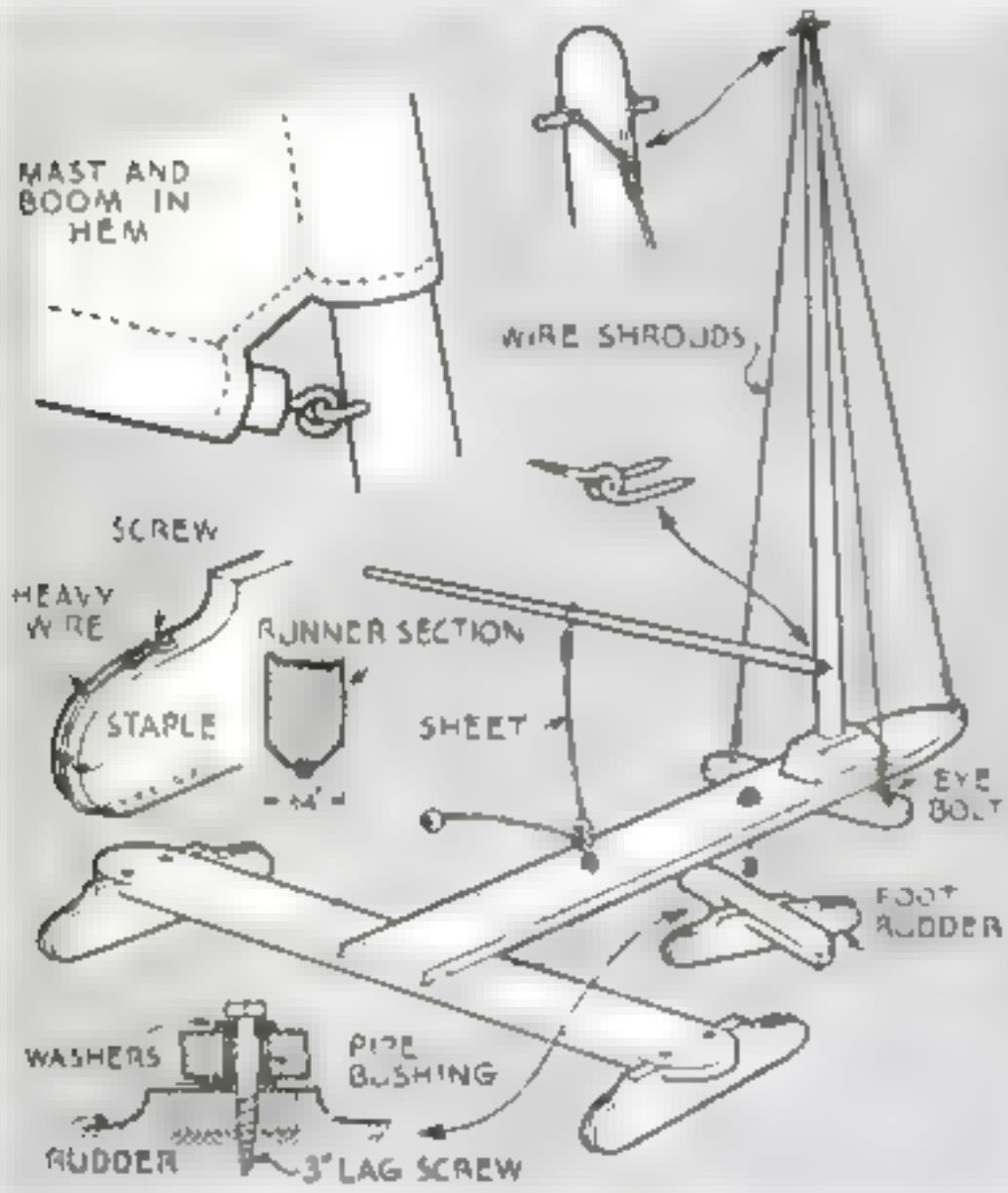
JANUARY, 1943

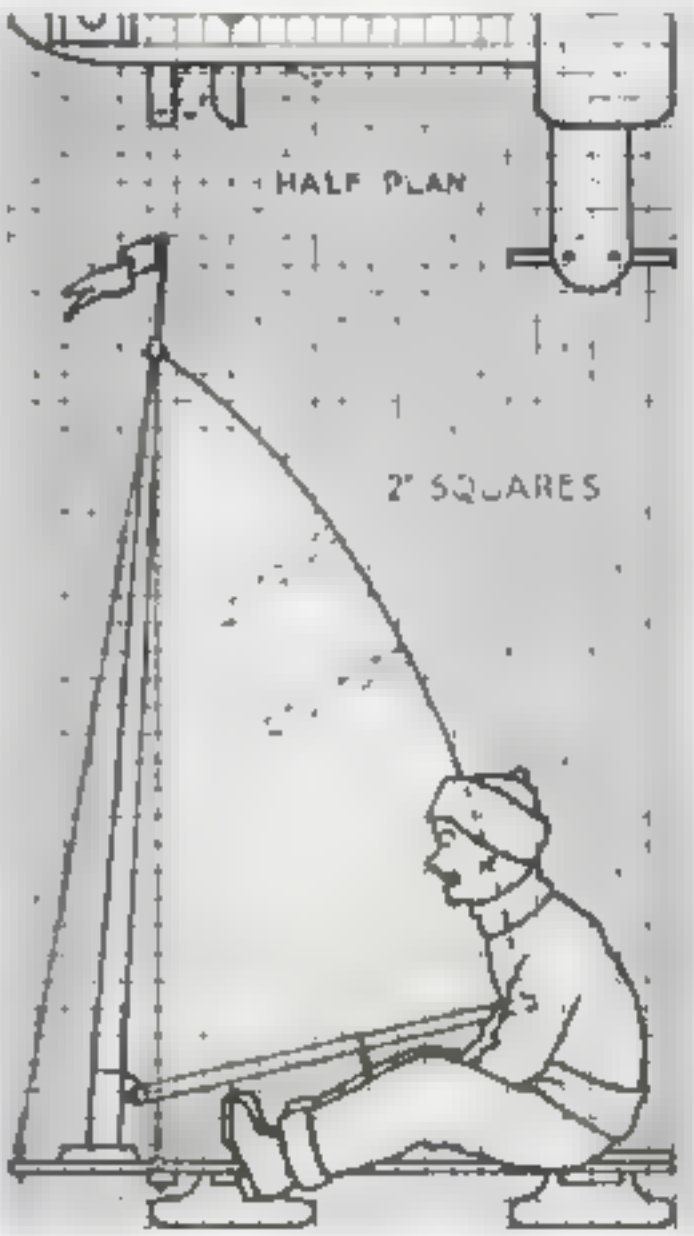
MIDGET ICE YACHT

Gives Youngsters Speedy Rides

THIS tiny iceboat, designed to carry a 10-year-old, is capable of enough speed to satisfy any youngster. Material to build it can be found in the average home scrap pile. Two ⅞" by 6" boards serve for the chassis; the mast is trimmed and tapered from a 5' length of straight-grained 2" by 2" stock; the 30" boom is formed from a shorter piece of the same material; and ¾" stock will serve for the runners. Brace the mast with wire looped over a pin at the top and drawn taut through eyebolts at the bottom.

To gain speed for the boat, cut grooves in the runners and lay in heavy wire, bringing it up around the curving ends and anchoring it with screws. Bevel the edges of the wood away from the wire along the whole length of each runner. The forward runner, or foot rudder, should be pivoted on a 3" lag screw, as shown in the drawing. Use washers as a bearing between the chassis and the rudder, and install a bushing in the hole in the chassis through which the lag screw passes. Unbleached muslin, hemmed as shown, forms the sail.—H. S

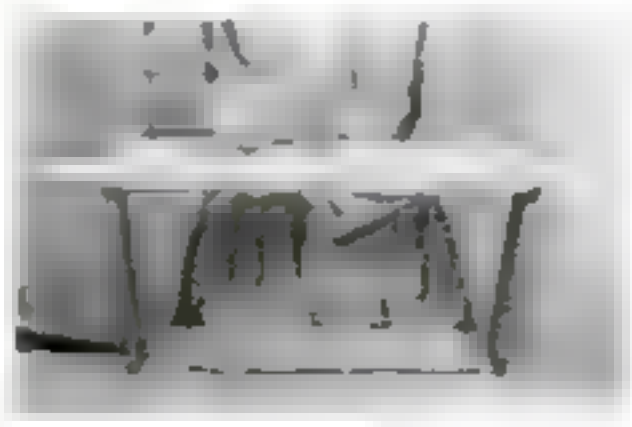




Yardstick Scaled from Middle Locates Centers Accurately

CENTER-LOCATING rules that can be made from a straight strip of wood will often save an otherwise perfect job from an unsightly off-center error. The wood stock should be about the same proportions as a yardstick, and a yardstick may be used as a guide in scaling it with drawing ink into divisions reading from the center toward each end as shown below. If preferred, paper may be glued over a yardstick and rescaled as indicated from a central reference point.

When held to the work so that the same readings are obtained at both ends, such a rule will indicate the exact center of a job at zero. Such household tasks as locating the center of a chair to be upholstered, fitting an eyelet in the center of a window shade, and locating a keyhole in the center of a drawer can thus be done with a great degree of accuracy.—H. B.



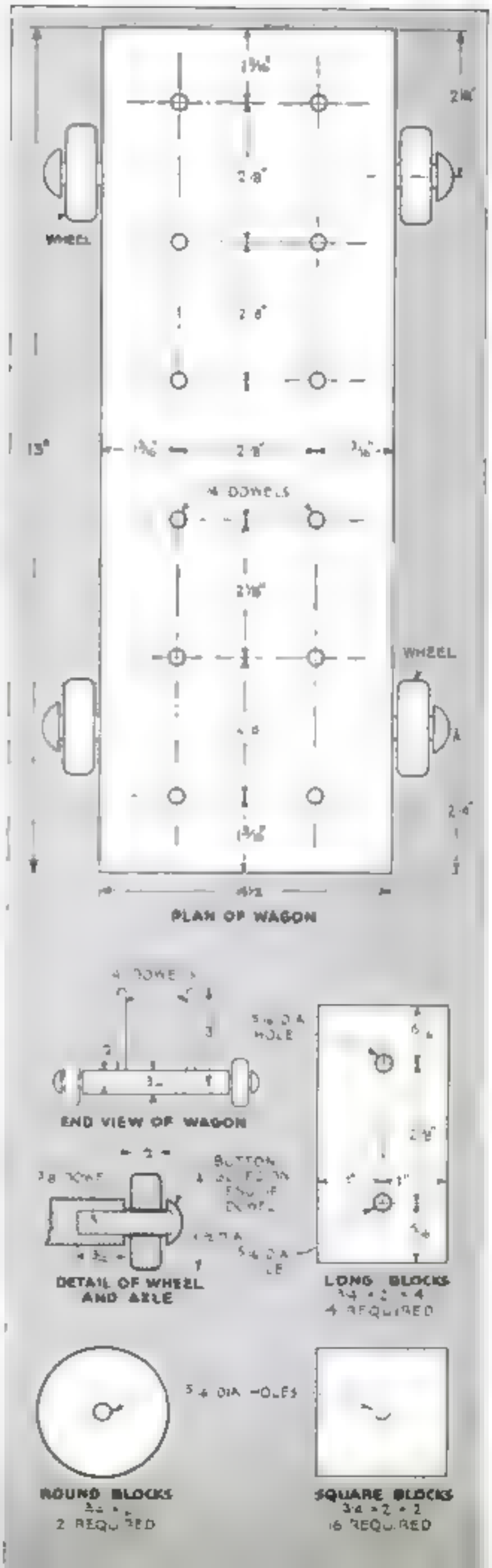
TOY BLOCKS AND WAGON

Keep Pre-Schoolers Busy

A TOY consisting of gaily colored blocks stacked on dowels atop a pull-about wagon is just the thing for the young construction engineer, boy or girl. It's fun for the child to haul the blocks to the job, either on the carpet or across the sand lot, and an absorbing game as well to stack them on their pegs when building operations are over.

The 12 pegs must be carefully located so that the blocks will slip into place easily. There are 32 blocks in all, but four of them are double blocks with two holes so placed as to allow the blocks to slip down over any pair of dowels.

Four wagon wheels are turned on a lathe, or they can be cut from a rolling pin and the edges sanded smooth. The 12 circular blocks could also be made from a rolling pin if a lathe isn't available. The wheels run on dowel axles glued into the edges of the wagon. Turn circular hubcaps and drill holes part way through them; then glue them to the ends of the axles to keep the wheels in place. A string for pulling the wagon can be looped through a hole in one end of the bottom board, or a small screw eye in the end of the board will serve the purpose even better, being less likely to fray the string quickly.—E. W.



JANUARY, 1944

Plowing Under

OFF-SEASON ADJUSTMENTS

By E. W. LEHMANN

Head of Department of Agricultural Engineering, University of Illinois

PLOWING—an essential operation on every farm before seed can be put into the ground—requires more power and more labor than any other single job connected with the production of crops. To reduce these to a minimum, a plow *must* be kept in first-class condition. If it is free from rust and is well adjusted, if its shares and coulters are sharp, its wheels properly set, and its hitch correct, and if all parts are tight, then a plow becomes a top-quality tool with which a man can do a real job.

All moldboard plows operate essentially on the same principle, whether they are walking plows, sulkies, or tractor plows. Their functioning parts are the share, the moldboard, and the land side, which are built around a frame or frog. Together, these parts are called the plow bottom, and they should be of a design suitable for operation in the soil for which the plow is intended.

If the moldboard is not kept free of rust, the plow will not scour, that is, soil will stick to its surface, and the result will be rough, uneven furrows. The application of abrasives, such as emery cloth, a polishing stone, a soft brick, or special grinding compounds, is a help if polished surfaces are corroded. A rusty plow may be made to scour by first using it in sandy or gravelly soil. At the end of the plowing season, coat all bright surfaces with a good hard oil or a rust-resistant compound, and check occasionally to be sure the surfaces remain protected.

The share must be sharp and properly shaped for penetrating the soil, cutting through the furrow, and turning the ground. Because a share is easily spoiled when not handled correctly, most farmers depend on experienced blacksmiths for sharpening. The process in-

Your Plow Troubles

OF THIS VITAL IMPLEMENT INSURE EASIER WORK IN THE SPRING

volves heating and hammering the share along one small part of the cutting edge at a time. The task is not difficult if it is well understood, if the necessary tools are available, and if overheating is avoided.

A warped share must be restored to its original shape while being sharpened. If it is made of soft-center steel, it should be hardened after sharpening by being heated to a uniform cherry red, then dipped into a tub of cold water or oil with the cutting edge down. A solid-steel share is heated and cooled in air, while the edge of a chilled cast-iron share—the type most used in sandy and gravelly soils—is ground.

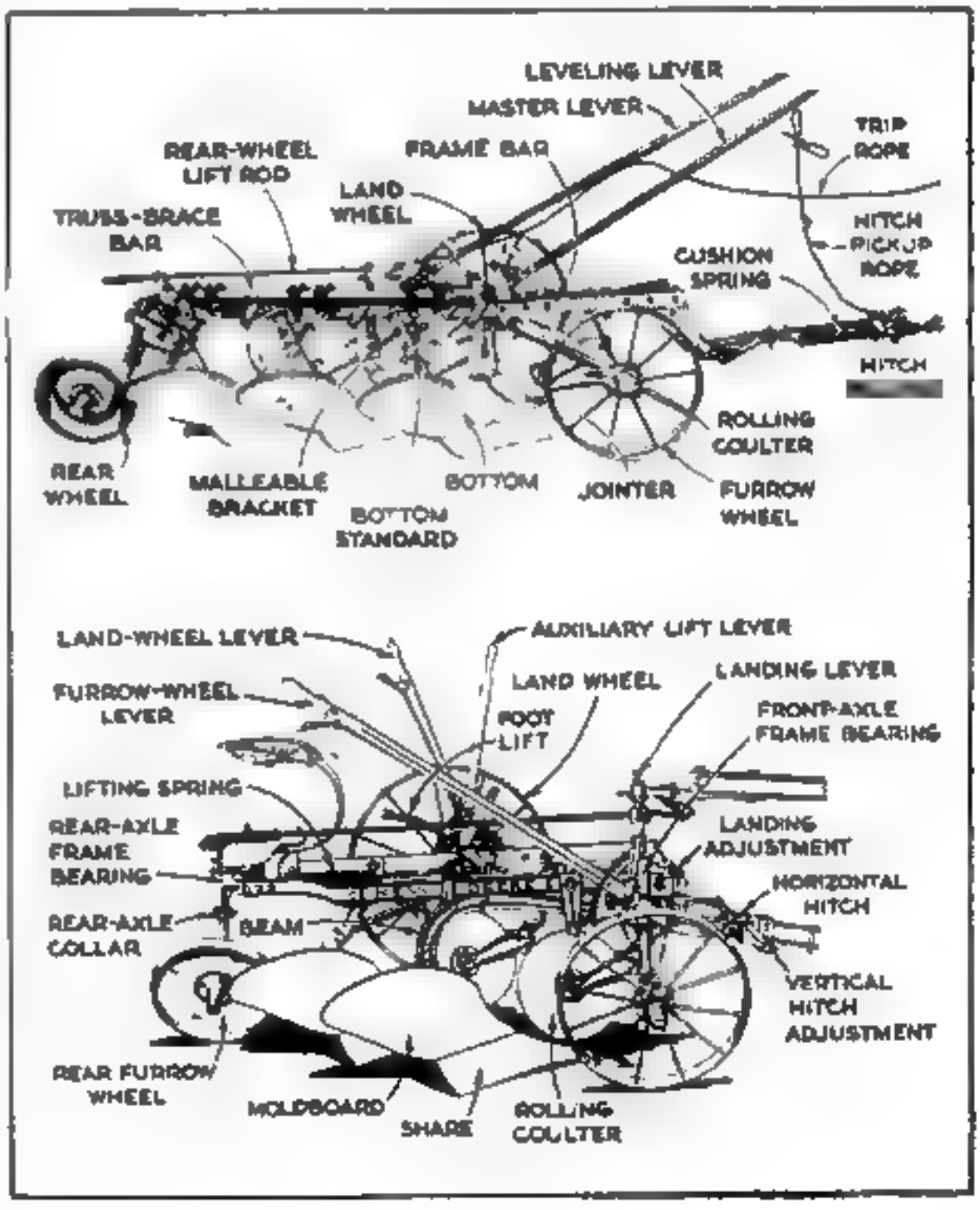
Set the share for "suction," that is, penetration of the ground, by turning the point down 1/16" to ⅛" as the share is shaped. Somewhat more of a turned-down point is better for tractor plows. The point should also be turned slightly toward the unplowed ground for what is known as "land suction."

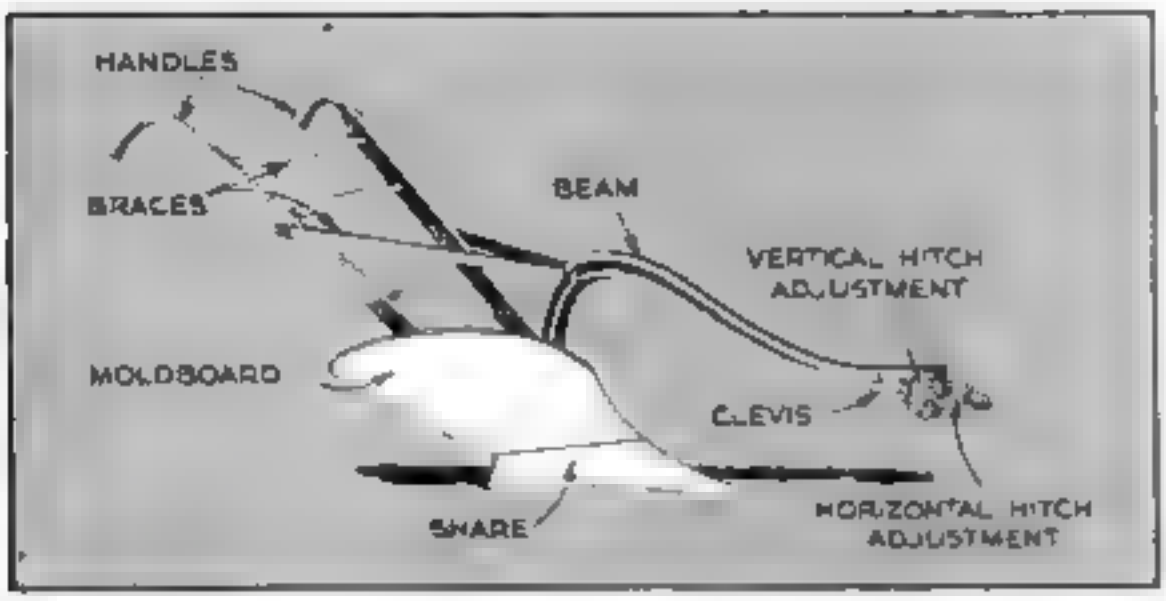
Examine the beam of a walking plow, and the beam and frame of tractor or horse-drawn riding plow, for bent sections or other distortions. Comparison of the shape with specifications in the manufacturer's instruction book, or with a new plow, will be a help.

It is always good practice to make a thorough check at the end of the season, noting all broken or badly worn parts, so that your order for replacements can be put in early if you do not have parts from an old implement available. Often a first-class repair can be made by welding, and frequently a welded part will outlast the rest of the plow.

All wheels on riding and tractor plows should be adjusted to aid in holding the plow steady and to reduce draft. Remove the wheels and wash the boxing, hub caps, and axles with kerosene, removing all old grease and dirt; then replace them and pack with clean grease. Adjust the front furrow wheel in or out to set the width of cut of the front plow bottom, keeping it running in the corner of the furrow. Make an adjustment of the rear furrow wheel for land-side clearance of ½" to ⅝" with the plow set in normal position on a level surface, following the instructions of the dealer or manufacturer.

The hub of the coulter should be approximately above and slightly back of the point of the share, with the coulter adjusted to penetrate somewhat into the soil as it cuts through trash. Set the jointer attachment so that it will cut about 3" deep and help to make a clean furrow. The point should just touch the coulter, which should



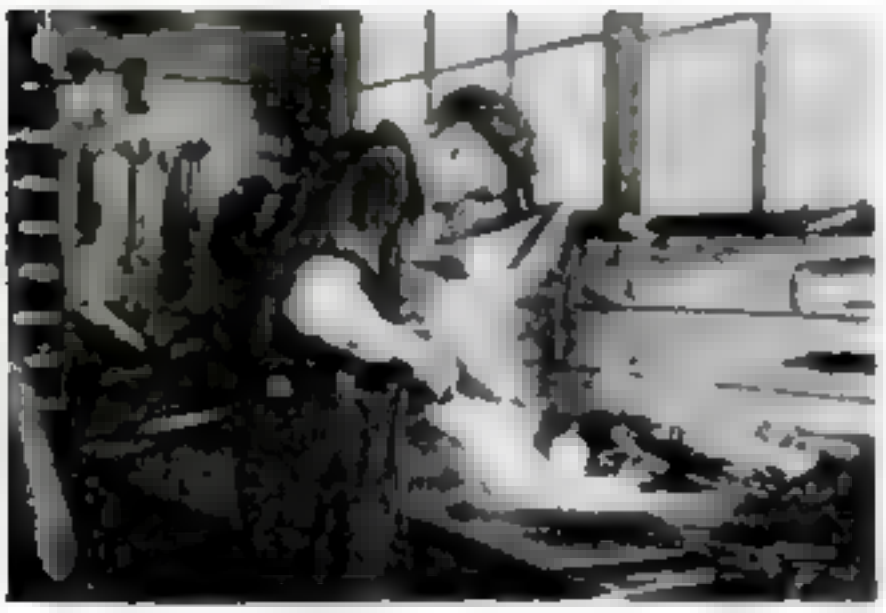


nevertheless be free to turn easily. Concave disk jointers, sometimes used instead of both a jointer and coulter, should be set so the center of the disk is approximately over the share point.

All levers require checking for straightness, bolts for wear, and lift springs for proper tension. There should be slight tension from the lift spring when the plow is raised out of the ground and the depth control and leveling levers are set for medium plowing of 6" or 7". Vertical and horizontal hitch adjustments must be such as to cause the plow to move forward smoothly without bobbing and without tending to go to either side.

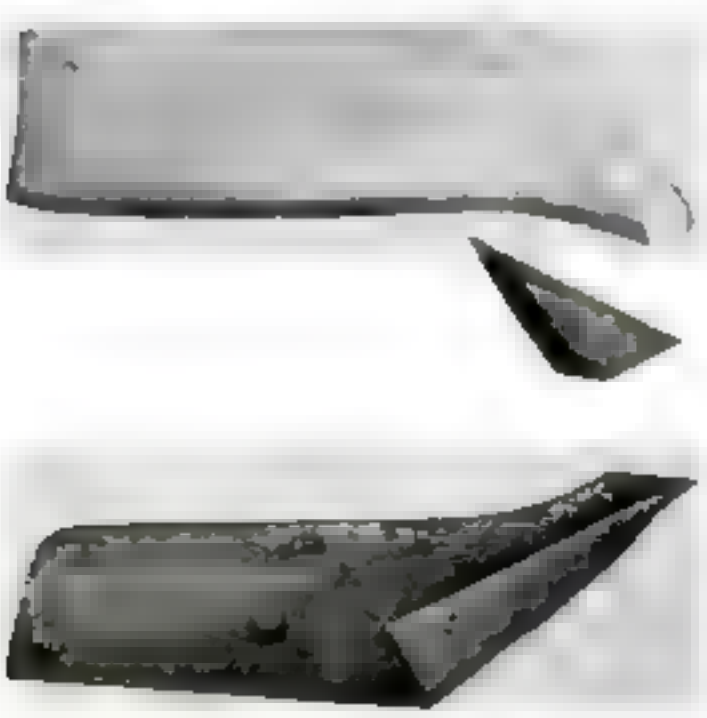
For best results, the center of load on the plow and the center of draft of a team should coincide. It is a good practice to string out the horses in tandem whenever you find that it is necessary to use a large team. If more than three horses are harnessed abreast, plowing becomes difficult and undue side draft is likely to result.

Welding New Abrasion-Resistant Edges to Worn Plowshares

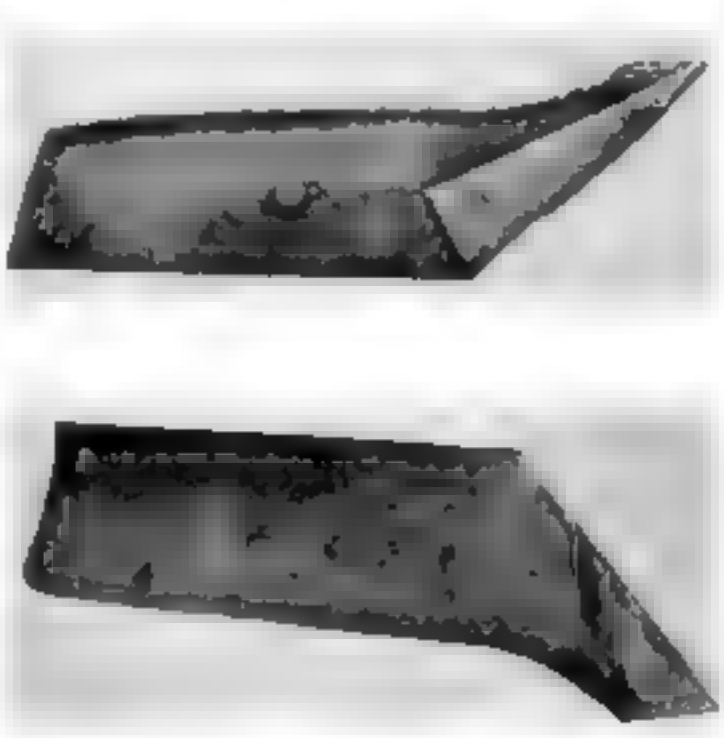


HARD-SURFACING, usually called hard-facing, will often make a worn plowshare as good as new. It consists of applying weld metal to the worn surface in order to build it up. With severely blunted shares, a new carbon-steel point may be welded on, after which the edge of the share is surfaced with an extra-hard welded bead. The share is then hot-forged to the proper shape. The stages in this process are shown in the accompanying photos from the Lincoln Electric Company of Cleveland.

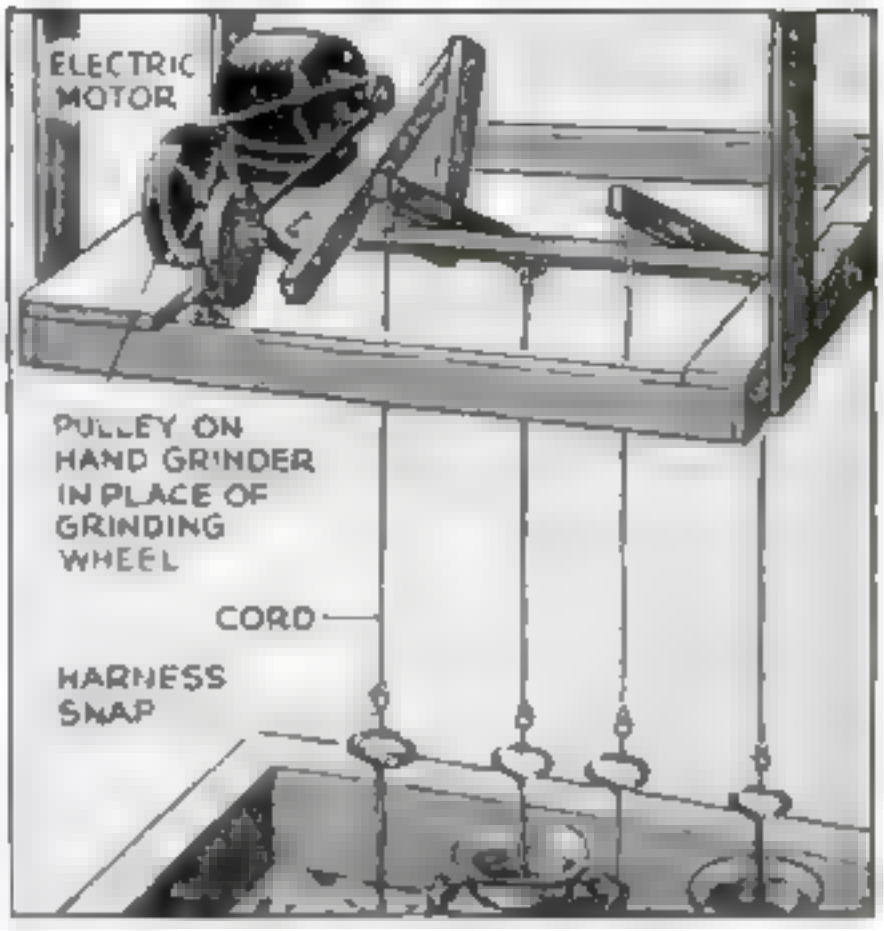
Cast-iron shares are repaired by welding with a mild-steel type of electrode. Care must be used to keep the share from overheating, since cracking might result. Electrodes for use on ordinary steel shares are made of a semiaustenitic alloy that is highly resistant to abrasion and increases in hardness during use. With plowshares of high-carbon steel, welding has sometimes proved difficult when attempted on an untreated share. In such cases, the share is first annealed and then hard-faced with abrasion-resistant electrodes.



At left, a worn plowshare before and after being reclaimed. Both sides are shown at right after the point in the first photo had been welded on. This step calls for an ordinary electrode, after which one made of an extra-hard alloy is used in resurfacing the cutting edge. A final hot-forging finishes the job



Mechanical Stirrer Speeds the Cooling of Milk in Cans



Dairymen will value this simple, motor-driven device for the time and labor it saves. It can be built on the farm from inexpensive odd parts

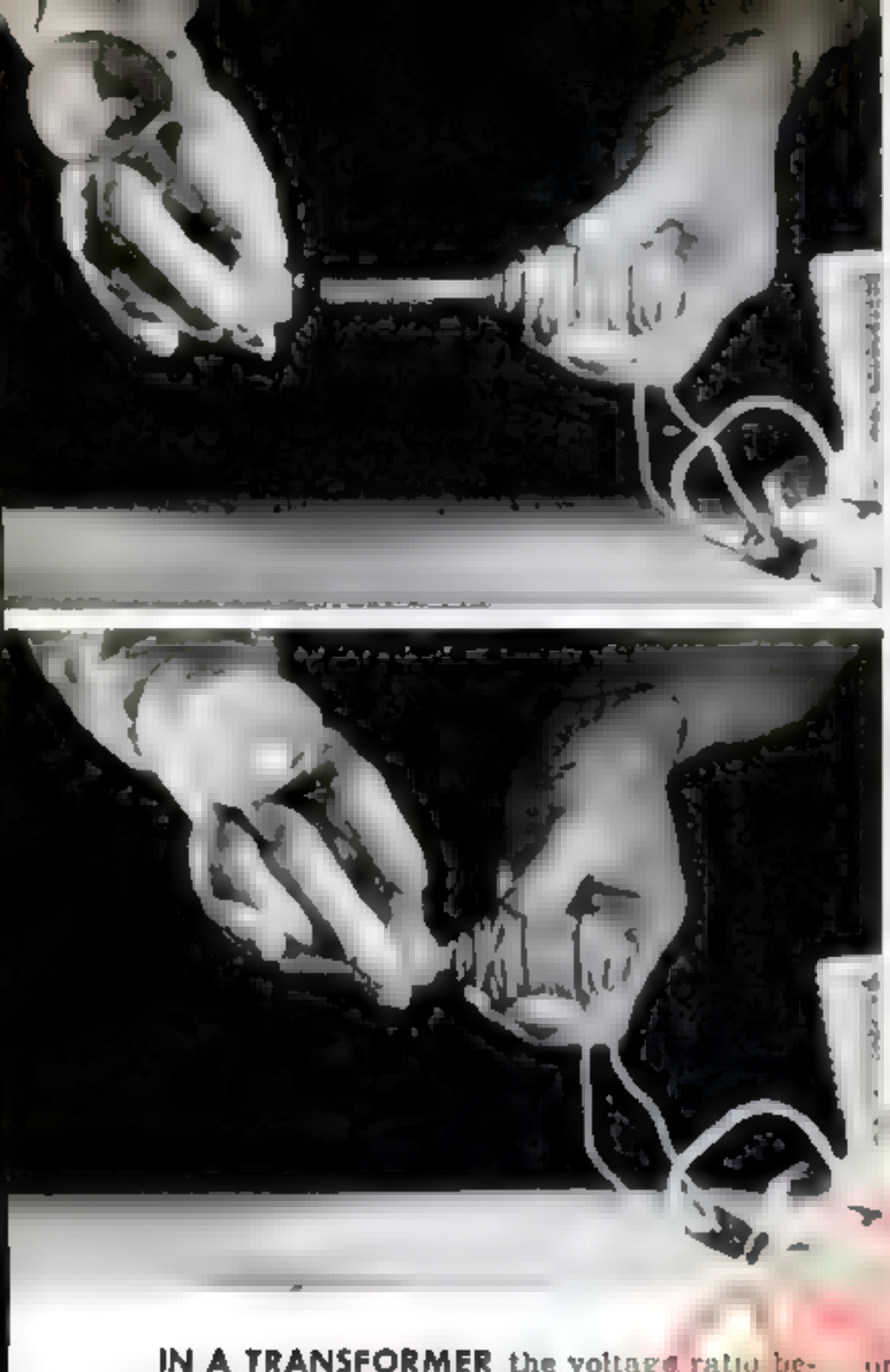
STIRRING greatly hastens the cooling of milk in cans, as every dairy farmer knows, and on many farms there will be found most of the materials needed to construct this electrically driven stirrer that will agitate the contents of three or more cans in a cooling tank. Simple in design, as the drawing shows, the stirrer exercises an effective double action, since it keeps both the milk and the cooling-tank water in motion.

Essential parts include a ¼-hp. motor, a speed-reduction gear, and a shaft for the rocker arms. The reduction unit can be made from an old hand tool grinder with a gear ratio of 10 to 1. A 2" pulley is used on the motor and belted to an 8" pulley, which is substituted for the grinding wheel. With a pitman bar fitted to the end of the grinder handle and connected to the rocker-drive arm, an oscillating motion is imparted to the rockers. Sash cords suspend hand stirrers in the cans and cooling tank. The device can be attached to the ceiling or hung from supports.—E. W. L.

JANUARY CHECK LIST [SHIPSHAPE HOME]

1. Remove snow from low-pitched roofs before it forms ice.
2. Clean gutters to protect them from the overburden of solid ice, dislodge icicles.
3. Brace rafters if a snow load tends to make them sag
4. Face-nail loose or squeaking floor boards, and set nailheads.
5. Wedge and glue or nail members of a creaking stairway.
6. Pry off uneven moldings at the bottom of baseboards and renail them close to the floor.
7. Patch worn or cracked linoleum floors.
8. Refinish unsightly wood floors, or lay new floors on top.
9. Clean out all plumbing traps and drains.
10. Renew or repair frayed extension electric cords.

POPULAR SCIENCE MONTHLY SHOP DATA



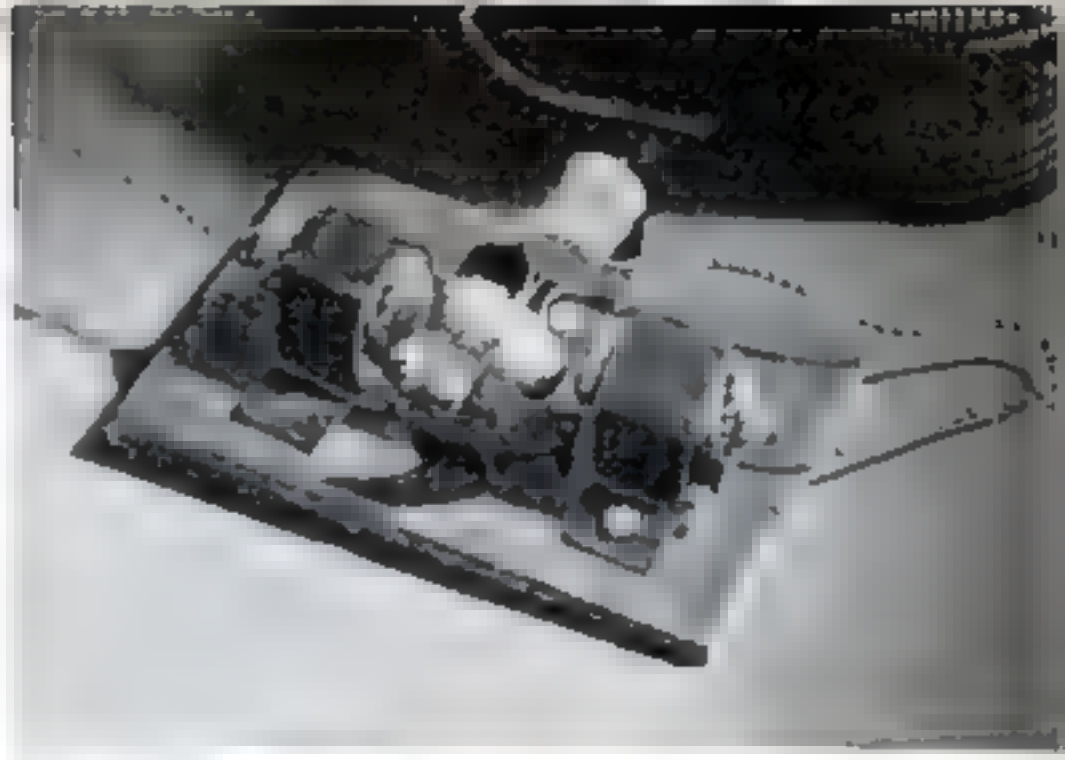
home EXPERIMENTS

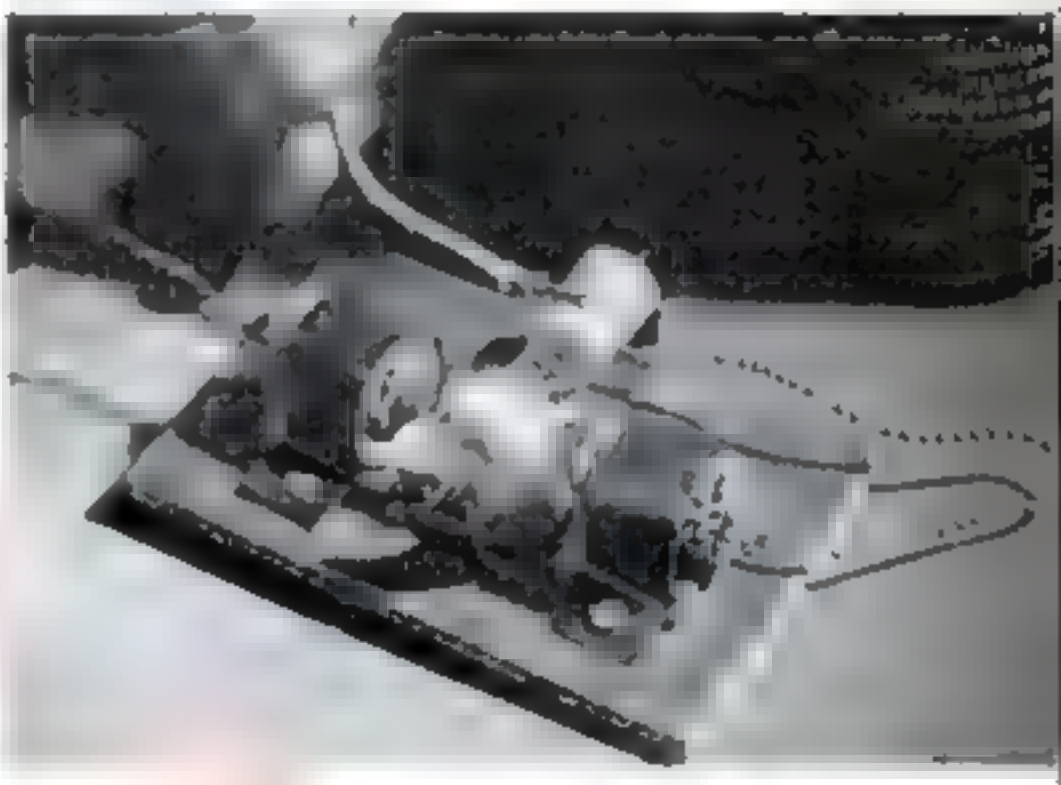
THE PRINCIPLE OF INDUCTION, which causes electric current to be transferred from one circuit to another with which it has no metallic connection, can be demonstrated with the simple equipment at the left. First, bring to a red heat an iron bolt about 6" long, and allow it to cool slowly. Then wind about 100 turns of bell wire around half the bolt nearest the head. Wind a second coil of about 200 turns of finer, insulated wire around a thick pencil or dowel of such a size that when it is removed the coil will fit loosely over the bolt. Connect a flashlight bulb and socket to the ends of this second coil, and then connect the ends of the coil on the bolt in series with a resistance such as a heater unit and to a source of 110-volt alternating current.

Now slide the second coil onto the bolt and the bulb will light, increasing in brightness as the coils are brought closer together. Transformers and spark coils operate on the same principle except that the efficiency of commercial equipment is increased by precise design of core and windings.

IN A TRANSFORMER the voltage ratio between the two coils is almost exactly equal to the difference in the number of turns in the coils. With 100 turns on the primary, or input coil, and 10 turns on the secondary, or output coil, the voltage from the secondary will be one tenth of that impressed on the primary. A transformer in which the secondary voltage is less than the primary voltage is called a step-down transformer. Bells and toy trains are operated with transformers of this type. With such a transformer in a 110-volt A C line, a low-voltage bulb may be lit safely.

That the voltage ratio is reversible can be proved by impressing low-voltage interrupted current on the secondary and obtaining high voltage from the primary. Connect dry cells in series with the secondary, connect a small, 110-volt argon lamp to the primary, and interrupt the current by drawing one of the wires lightly over a file connected in the circuit, as illustrated. The lamp will glow brilliantly, although only one pole will light up. This is due to the fact that direct current is employed. If you reverse the leads, you will find the opposite pole will light when the intermittent current is supplied.





A HOMEMADE D.C. MOTOR that will really run can be constructed quickly by duplicating the apparatus at the right. Two bolts about 2" long should be annealed by heating, as in the first experiment, and then wound with a continuous length of bell wire. Wind 50 turns clockwise on one bolt, leave 4" straight, then wind 50 turns counterclockwise on the other. The direction of winding must in both cases be considered from the bolthead end. Mount the bolts about 2" apart with head facing head. Then, when connected with one or two dry cells, they will become the field magnets of your motor.

For an armature, or rotor, wind a slightly smaller bolt with about 50 turns of finer wire and mount the unit on a shaft contrived by thrusting a length of stiff wire through the coils of the winding. Crude bearings and a commutator are now all that are needed to complete the motor.

The bearings are strips of notched tin. A cork will make a good commutator when fitted with two strips of thin sheet metal Press the cork onto the rotor shaft, as indicated, and glue the two strips of sheet metal to its sides. The strips should be just wide enough to go around the cork except for slight separations between them. Solder the two ends of the rotor windings to these improvised commutator segments; then arrange a terminal wire from one of the field magnets so that it presses lightly against the underside of the cork, and connect the other wire from the field poles to one terminal of several dry cells in series.

Hold the other terminal wire from the dry cells lightly against the cork, as shown, and the motor will spin rapidly. The function of a commutator is to reverse the direction of current flow through the armature twice in every revolution so that each pole is first attracted and then repelled by the adjacent pole of the field magnet.

ELECTRIC GENERATORS produce their current by rotating wire coils between the poles of powerful magnets so that they cut magnetic lines of force. This principle of an electric alternator may be demonstrated by means of the equipment used above, minus the commutator, but with a galvanometer added to the circuit as shown below.

For the galvanometer, use a toy compass wound around the center with 50 turns of fine, insulated wire. Connect this current-detecting device with the two ends of the armature winding, and station it far enough from the magnets so that the needle will not be influenced by stray magnetism. If you now twist the rotor shaft while current flows through the field coils, you will discover that the compass needle is deflected first in one direction and then in the other as the rotor passes through each half of a full turn. In a regular alternator, brushes would collect alternating current from rings fitted around the rotor shaft and connected with the windings which are built into the rotor.

Phosphorus heated in a solution of lye produces phosphine, which ignites on contact with the air

By KENNETH M. SWEZEY

Mysterious PHOSPHORUS

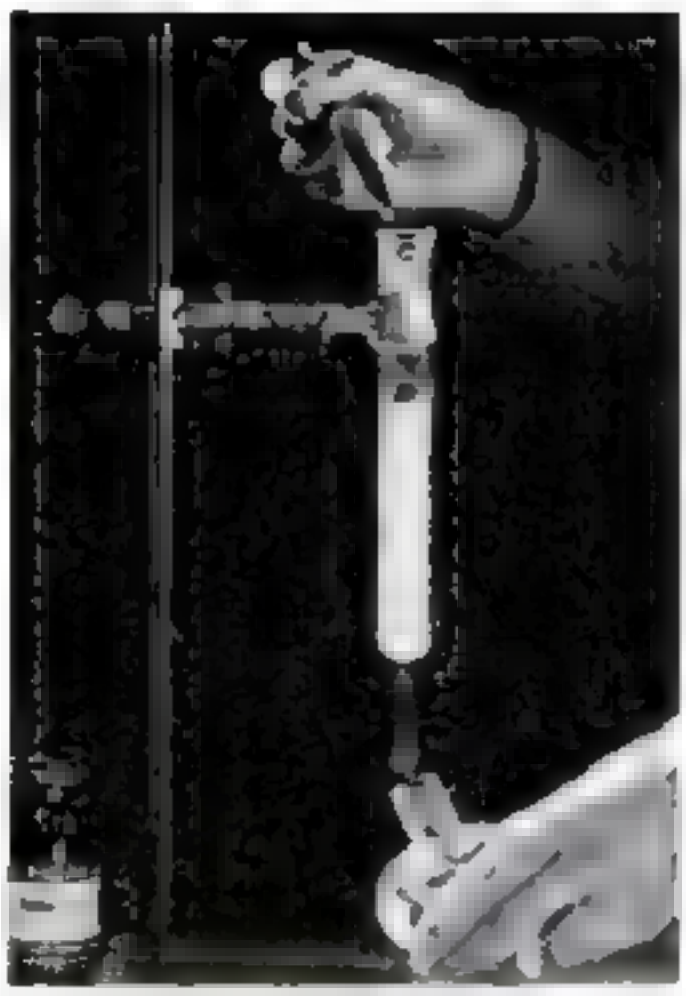
PHOSPHORUS, that curiously active, waxlike element glows weirdly in the dark and ignites spontaneously, accompanied by clouds of dense white smoke. It was discovered, appropriately enough, in an alchemist's musty laboratory nearly three centuries ago. Brand, of Hamburg, chanced upon it while experimenting in search of the mythical philosophers' stone.

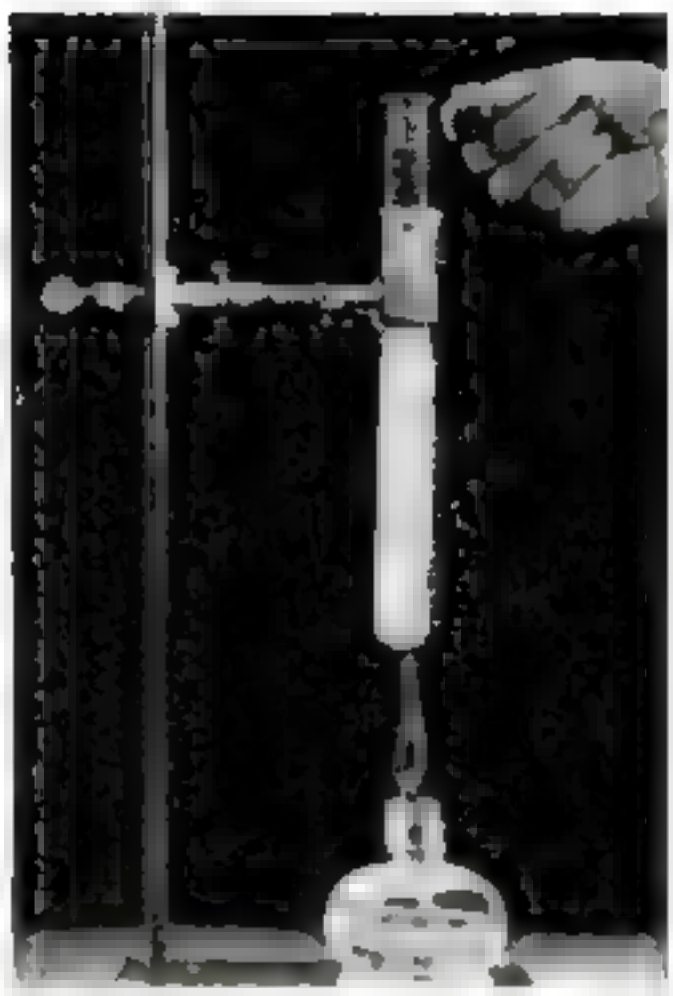
Now phosphorus is found abundantly in compounds. Too chemically active to be found in the uncombined state, the element exists in all animal and vegetable life, in earth deposits as phosphate rock, in most river and spring water, and in the sea. Bones are made up of about 58 percent calcium phosphate. In Florida, South Carolina, and Tennessee there are great deposits of phosphate rock, probably the fossil remains of prehistoric animals.

Phosphorus is made by heating phosphate rock or animal-bone ash with sand and carbon in an electric furnace. In the reaction carbon monoxide is burned, calcium silicate is drawn off as slag, and phosphorus is distilled over and is condensed under water.

An ounce of white phosphorus in thin

Fumes from burning phosphorus collect in this test tube





Adding a speck of iodine as a catalyst helps change white phosphorus into the relatively inactive red variety. At right, continued heating changes the red phosphorus back to white, which condenses on the small tube inside the other

sticks is sufficient for many experiments. The chemical is extremely poisonous and combustible. Take care to store it under water; *always* handle it with forceps or tongs, *never* with the fingers (phosphorus burns are poisonous and difficult to heal); cut it only under water; return unused pieces to the water-filled bottle immediately; and burn waste bits.

To produce smoke like that used for smoke screens, cut under water a piece of phosphorus about half the size of a pea. Place this on a slice of cork, float it on a pan of water, light the phosphorus, and cover it with a large inverted test tube. Dense white clouds of phosphorus pentoxide will form and collect in the tube

This "smoke," which is really a light, finely divided powder, combines avidly with water, drawing some of the water from the pan violently into the tube, and will disappear in solution after several minutes. Testing this water with litmus paper will disclose that it has become strongly acid. The acid is phosphoric acid, from which phosphates are produced, and it is prepared in its purest form by dissolving phosphorus pentoxide in distilled water. Because of its great affinity for water, phosphorus pentoxide powder is often used for drying gases.

If exposed to air at temperatures above 94 deg. F., white phosphorus catches fire spontaneously. Below this temperature, slow oxidation causes its surface to glow in the dark. This glow may be demonstrated with "magic" paint. In a test tube dissolve a pea-size piece of phosphorus in 10 ml. carbon disulphide (*keep away from flame*). Add 10 ml. olive oil, and shake gently to mix. Paint with it on heavy cardboard, being sure to immerse the brush in water immediately after use to prevent spontaneous combustion, and clean it later in carbon disulphide and then in alcohol. In the dark, the letters or figures on the cardboard will glow with a weird, pale light. Blow on them, and they disappear—only to reappear again when you stop blowing

Phosphorus dissolves in carbon disulphide without oil causes a more spectacular re-

. . . the Alchemist's Element

action. Spread a few drops of this solution on a piece of filter paper placed in a pie tin or held over a tin by a clamp. The phosphorus will catch fire spontaneously when the solvent evaporates and will set fire to the paper.

Though quick to start a fire, phosphorus has a relatively low heat of combustion and most of its heat is directed upward. It therefore usually causes little damage except when in contact with flimsy materials, and a phosphorus fire is best fought by protecting nearby combustible material with a water spray while allowing the phos-

"Magic" glowing paint is a solution of phosphorus and carbon disulphide to which olive oil is added

phorus to burn itself out in its own time.

Strangely enough, poisonous and readily combustible white phosphorus (sometimes called yellow) has a brother, red phosphorus, that is not poisonous and does not catch fire until heated to 240 deg. C. Red phosphorus is now used in great quantities in matchmaking, replacing white phosphorus, which was a source of widespread bone disease among match workers.

Mount a large test tube vertically on a stand, drop in two pea-size pieces of white phosphorus, and apply a small flame. The phosphorus may start to burn, but its own inert fumes will soon cut off oxygen. Under continued heating, the white phosphorus will gradually turn reddish. Add a speck of iodine crystal, a catalyst, and the change from white to red phosphorus will be almost instantaneous.

To change the red phosphorus back to white, fill a smaller test tube with cold water, twist a piece of wire around its neck for a support, and lower it into the large tube. Heat the large tube more strongly than before, and fumes will arise from the red phosphorus and condense as crystals of white phosphorus on the outside of the cool inner tube. When the whole apparatus has cooled, lift out the small tube by means of tongs, and the white phosphorus on its surface will ignite spontaneously a few seconds after contact with the air.

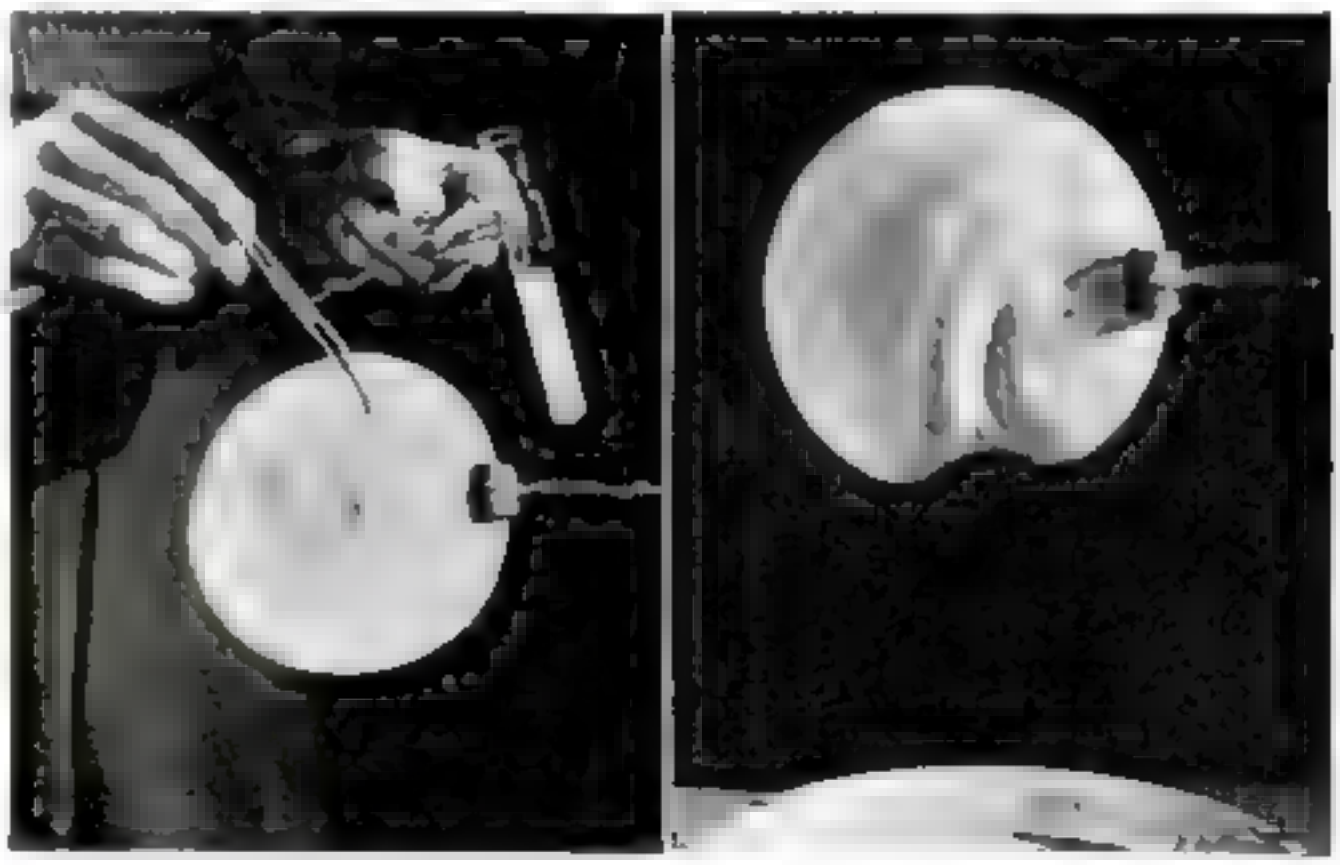
Phosphine, a gaseous compound made by uniting phosphorus with hydrogen, may be the subject of an interesting experiment, which must be performed in a well-ventilated room and with care paid to details.

Half fill a side-necked test tube with a strong solution of lye or sodium hydroxide, allow it to cool, and add a pea-size piece of phosphorus. Fit the tube with a one-hole stopper through which passes a glass tube reaching nearly to the bottom of the test tube. Clamp the test tube to a ring stand, and connect its side arm to a long glass delivery tube having an upward bend at its lower end. This end of the delivery tube is placed in a pan of water with its opening submerged about ¼".

Connect the tube from the test-tube stopper to a source of illuminating gas through a rubber tube having a screw pinch clamp. Make sure all connections are absolutely tight; then flush all air from the system by allowing illuminating gas to bubble through for a minute or two, after which turn off the gas and close the pinch clamp tight. This flushing prevents spontaneous combustion of the phosphine.

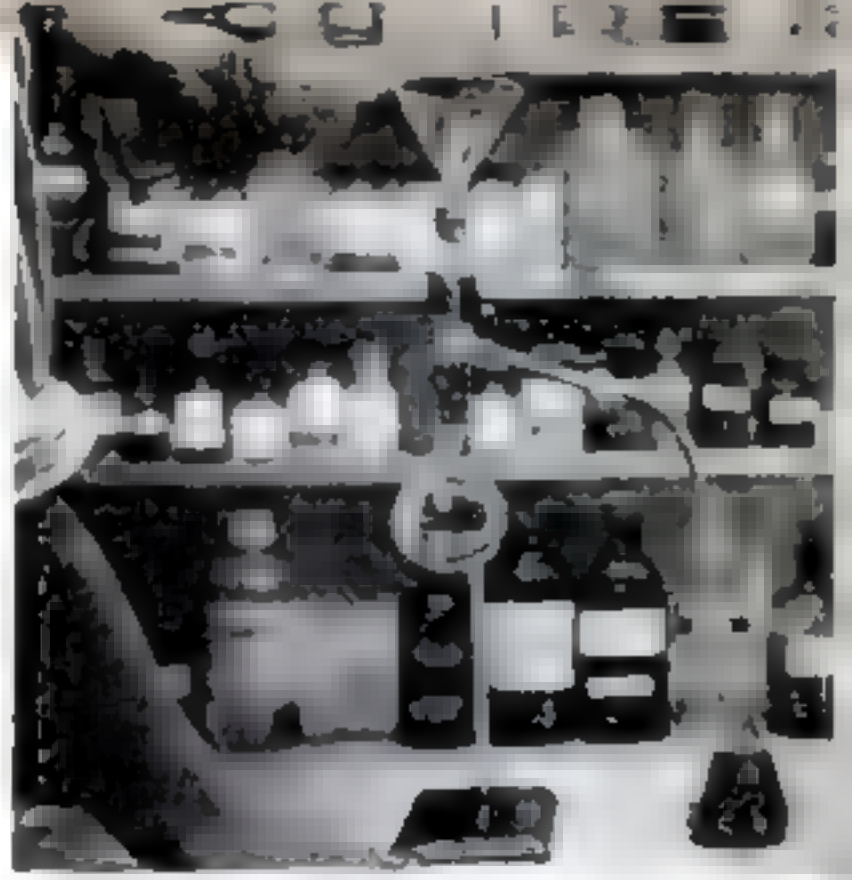
Now heat the test tube gently. Bubbles of gas will soon rise in the solution and pass through the delivery tube and up through the pan of water. After a few minutes of operation, each bubble escaping through the water will burst into a little puff of flame as it comes in contact with air, the flame often changing into a beautiful smoke ring.

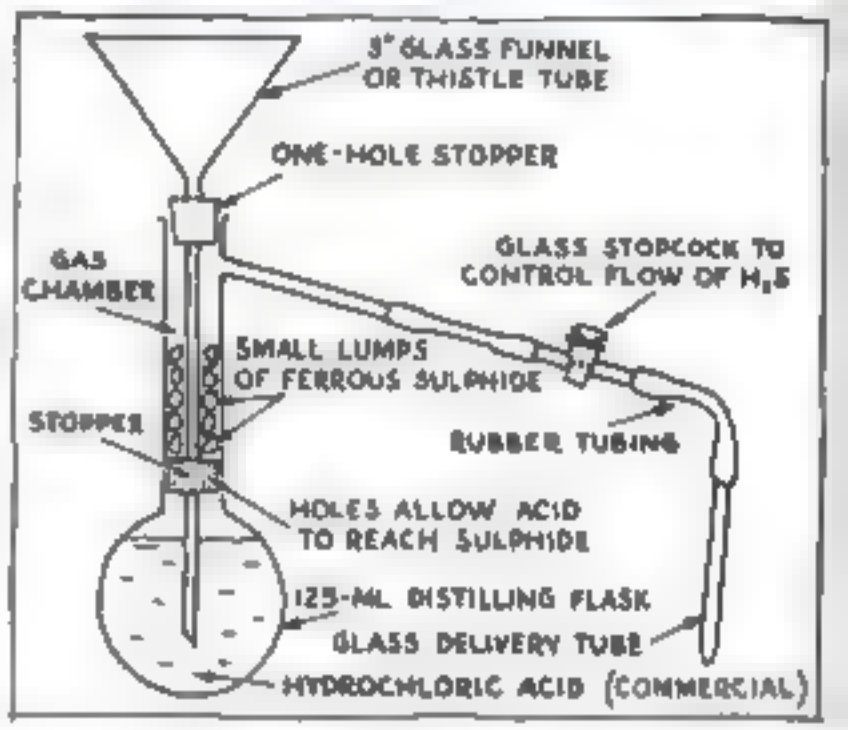
Pure phosphine itself does not ignite spontaneously at room temperature; it is a trace of a related compound that sets it afire. Phosphine is poisonous; therefore do not continue the experiment too long. To stop the reaction, carefully fill the pail with water and remove the flame under the test tube. When the vapors cool, water will be drawn into the apparatus. Remove the stopper after all tubes cool.



Leaving out the oil causes the phosphorescent solution to ignite paper

Simple Hydrogen Sulphide Generator Is an Aid to Amateur Chemists



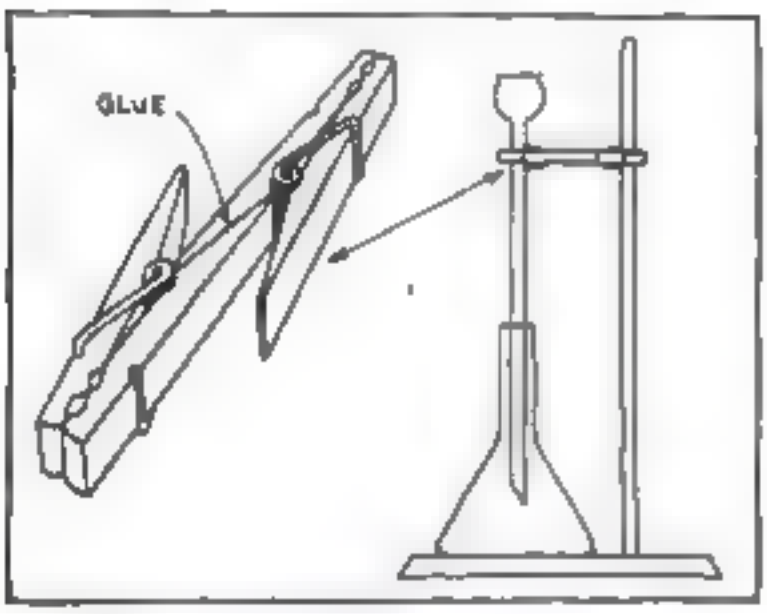


INEXPENSIVE apparatus for the generation of hydrogen sulphide in the home laboratory can be constructed in short order by duplicating the arrangement shown in the diagram. On a small scale, this setup will serve the purposes of a Kipp generator, and should provide enough hydrogen sulphide to fill all the needs of the amateur delver in analytical chemistry.

The apparatus consists principally of a 125-ml. distilling flask and a 3" funnel with a long stem. As in the drawing, the stem of the funnel is fitted through two stoppers in the neck of the flask, the lower stopper having a central hole and also two auxiliary holes through which acid passes as it rises from the bulb of the flask. On top of this stopper, around the stem of the funnel, are placed small lumps of ferrous sulphide. The distilling arm of the flask is extended by a stopcock fitted between rubber tubing further extended by a glass tube.

Warm hydrochloric acid is then poured down the funnel until it rises in the flask sufficiently to pass through the three-holed stopper and reach the sulphide. Gas from the reaction will pass the open stopcock and bubble through the solution to be tested. When the stopcock is closed, gas pressure will keep the acid from rising, and stop the action until the cock is reopened.—RICHARD BECK.

Two Clothespins Form a Lab Clamp



GLUING two spring clothespins together, as indicated in the drawing, will provide a clamp that will come in handy for many purposes in a laboratory, such as holding glass tubing, funnels, and thistle tubes. It will also do much to reduce the breakage of fragile parts. The pins should be joined with a good grade of waterproof glue. If a C-clamp is not available, a third pin can be used to hold the legs of the other two pins together under pressure as the glue dries. When properly joined, homemade clamps of this kind will last a long time and prove themselves to be highly useful.—ANDREW LEE PECKEM, JR.

Wood Strip Prevents Short Circuits

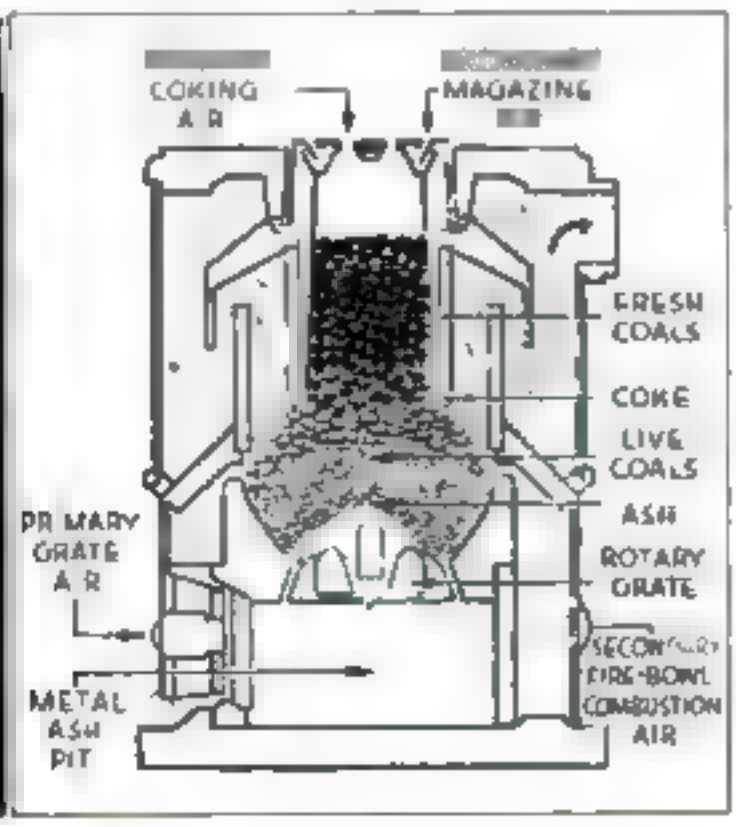
SHORT circuits sometimes do much damage to costly apparatus when a test cord attached to spring clips is used to connect electrical equipment. Such mishaps can be effectively guarded against by clipping the equipment leads upon a thin piece of wood, or other non-conductor, as in the photograph. This will keep the clips from accidentally swinging against each other and thus causing a short circuit which might do irreparable damage to the electrical equipment. Little time and effort are required for this simple precaution.—W. E. B.

STORM BAY WINDOWS of plastic glazing, like the one at the left, will add to the winter comfort of many home owners as soon as military demands cease to absorb the supply of the plastic material. Heat-retaining properties of the glazing, coupled with its high ultraviolet ray transmission, fit it especially for enclosing space for a window garden or a bay for a child's crib.

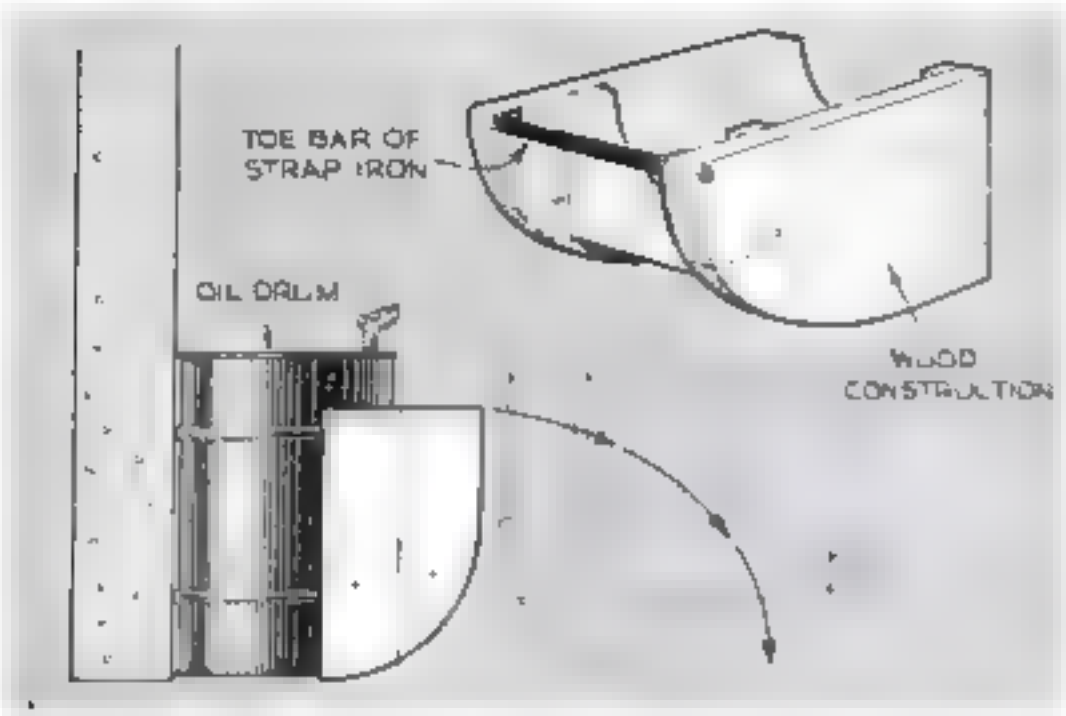
SHOWER HEADS made entirely of plastic are finding a wide use in lieu of heads made partly of plastic and partly of metal. Even the joint and the threaded connection of the new head are of plastic, an advance in design over units of dual composition.

A COLOR WHEEL will save users of this tung-oil paint from mistakes in selecting wall and trim colors that do not harmonize with the basic color of furniture and hangings. The wheel presents a wide variety of multicolor combinations. If turned until a desired basic color is in one window, it shows complementary and contrasting hues.

CERAMIC HEATERS constructed mostly of hollow tile, and now in the process of perfection by engineers of Ohio State University, may soon reach quantity production. Made possible by the careful blending of raw clays—more than one type of mixture is needed to make a complete unit—the ceramic heaters embody a method of combustion by which a charge of coal is reduced to coke within the stove before it is ignited. Heat is transferred from the center of the stove to narrow convector passages formed by openings in the hollow tile of which the wall is constructed. These vertical tubes surround the fuel magazine and impart enough heat to a charge of coal to coke the charge before it is fed by gravity to the combustion chamber. In addition to the model illustrated, other designs include an oven, a hot-water heater, and a ceramic range.



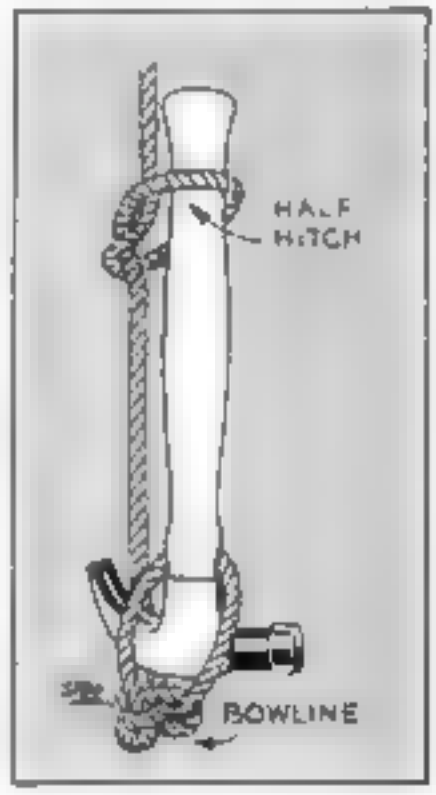
Tilting Stand Makes Oil Drum Easy for One Man to Handle



DRUMS of oil can be handled easily by one man if he uses a tilt-type drum stand like the one shown at the left. After the drum has been placed in position with the oil cock at the top, it is tilted back slightly and the stand is shoved against it with the toe bar under the front edge of the drum. When the stand is rocked forward, it will pull the drum with it and lay it on its side. In this horizontal position, the drum can then be readily shoved about until it reaches the desired location.—JOHN LAPIN.

Tools Hoisted Safely with Bowline and Hitch

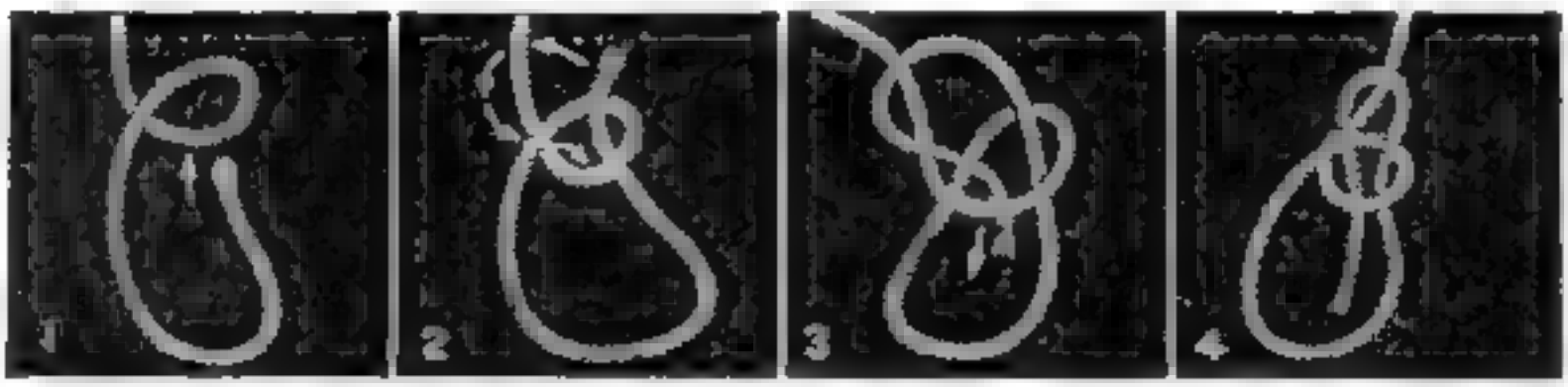
SLINGING an ax or a hammer securely, when such tools are to be pulled aloft, will guard those below against injury and at the same time prevent the minor mishaps so often caused by an object dangling haphazardly at the end of a long rope. A bowline affords the best precaution against both types of accidents After the loop has been slipped over the head of the ax or hammer, the rope should be carried nearly to the end of the handle and thrown around it in a half hitch, as in the illustration.—W. H. D.



Packing-Case Lumber Cuts Cost of Small Jobs

MANY things around the house, especially shelving, can be built economically from lumber used in the wooden cases in which sheet glass is shipped. Such stock is likely to be of a low grade, but in 3 to 6' lengths it is adequate for many purposes, and it will save the cost and bother of frequent lumber-yard purchases.—N. E.

THE BOWLINE [KNOTS]

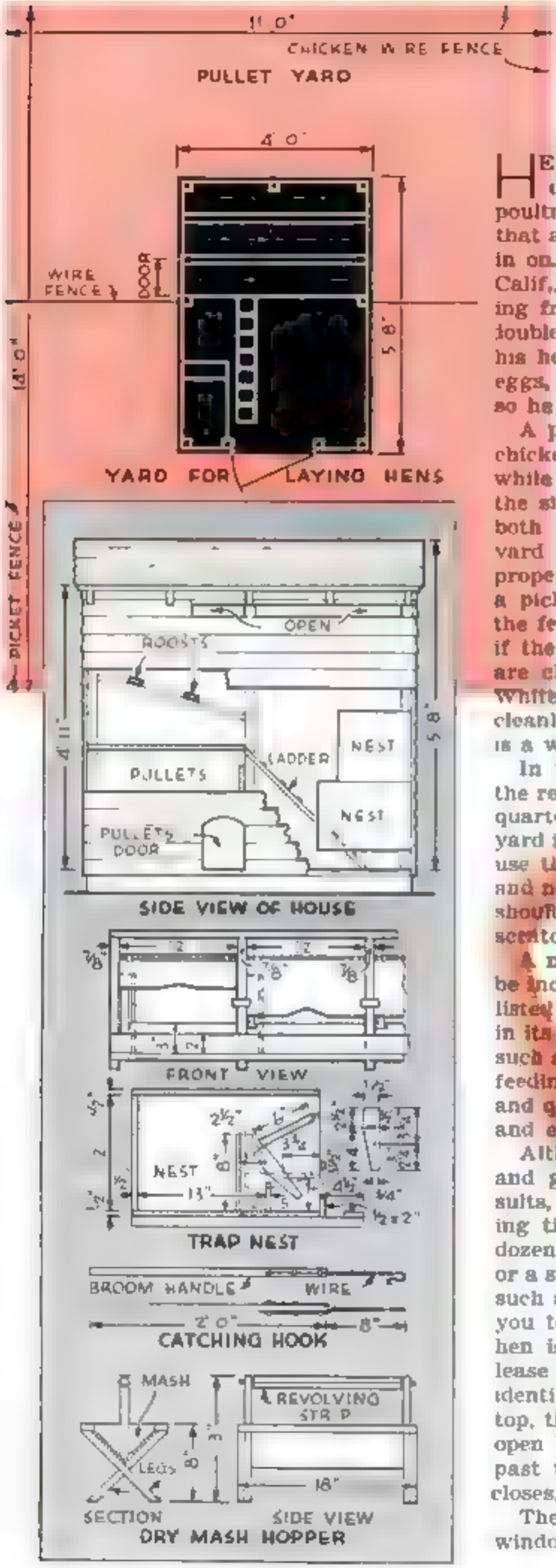


Called the "King of Knots" and regarded as the best fixed loop ever devised, the bowline, unlike the overhand loop, is easily untied. In addition to this virtue, it is one of the easiest loops to fashion when once its technique has been mastered

In order to tie a bowline knot, hold the rope as in Fig. 1 and carry its length in a counterclockwise direction around the end, as in Fig 2. Then pass the end under the length and back into the small loop, as in Fig. 3. Now, holding the doubled end in the left hand, as in Fig. 4, pull the knot tight with the right hand

POPULAR SCIENCE MONTHLY SHOP DATA

Bigger Dividends



HERE is a banker who carried the idea of dividends from his bank to his back-yard poultry house and made it pay. It is an idea that anyone with a few feet of space may cash in on. When A. W. Pipes, of South Pasadena, Calif., went in for raising chickens after retiring from the banking business, he acted on a double-barreled theory and got results—he made his hens comfortable so they would lay more eggs, and he made his poultry yard attractive so he wouldn't mind working in it himself.

A plan for his yard and his two-apartment chicken house is given at the top of this page while photographs on the facing page show the steps he took to give the unit eye appeal both for himself and for his neighbors. The yard is in a back corner of his lot with the property fence enclosing it on two sides and a picket fence on the other two. If desired, the fences can be backed by chicken wire, but if the property fence is tight and the pickets are close enough, this will not be necessary. White paint adds to the general appearance of cleanliness, while a touch of color on the roof is a welcome and attractive note

In the chicken yard shown, pullets occupy the rear portion of the run and the back, lower quarter of the house. The front part of the yard is given over to laying hens, and they also use the roosts at the upper rear of the house and nest boxes in front. The floor of the house should be wood or concrete. Litter on it for scratching must be changed periodically

A number of practical details that may well be incorporated in any plan similar to this are listed by the U.S. Department of Agriculture in its Farmer's Bulletin No. 1554. These cover such subjects as nests, ventilation, heating, and feeding for the improvement of both the quality and quantity of a small flock's output of meat and eggs

Although poultry requires sunlight, warmth, and generally dry surroundings for best results, there should be dark nests for use at laying time. Three of these are sufficient for a dozen hens. The openings should be at an end or a side rather than on top. Simple trap nests, such as the one shown in a drawing, will help you to check production. With this device, a hen is imprisoned after laying until you release her, thus giving you an opportunity to identify your good producers. Hinged at the top, the door of the trap nest is normally held open by a pivoted catch. When a hen pushes past the door, the catch drops and the door closes, held shut by the catch.

The house should be well ventilated with windows or slits high in the walls at or near

from Back-Yard Poultry Flocks

the front and back. When the weather is very hot, both front and rear vents should be kept open. In cold weather it is best to open them at only the front end of the house, and then possibly not more than a few inches.

Hot water or small stoves will provide sufficient heat for your flock, but it will be necessary to employ artificial heat only in the coldest weather. It is a better plan to insulate the house by constructing a double wall at the rear—the inner one either of wood or composition board. A double ceiling is advisable where the climate is extremely cold.

Electric lighting may be employed to provide a 12 full or 14-hour laying day, thereby increasing egg production during the fall and winter months when it is at its lowest. Two 40-watt lamps with 16" reflectors will be adequate for a house having 20 sq. ft. of floor area. They should be installed near the ceiling.

Dry-mash hoppers pay for themselves by cutting down waste and keeping dirt out of feed. They consist essentially of two boards nailed together at right angles and attached to a frame, as shown in a drawing. Crossed pieces at each end serve as legs. A revolving strip set up over the center will prevent the birds from roosting on the hopper.

Sprouted oats or other root-bearing grain is a good item to include in the feed. This can be prepared by soaking the grain and allowing it to sprout on trays that drain well. Also needed will be some form of commercial scratch feed or cracked grain that can be thrown into the litter to force the chickens to exercise.

For reasons of health, drinking stands should be raised about 12" off the floor. One simple arrangement consists of a platform of slats built against a wall and containing drinking vessels or a fountain. The platform should be large enough to give the chickens standing room. Wire over the vessels will keep them from getting their feet wet.

A useful accessory is a catching hook. It is made by attaching a wire to a wooden handle, as shown in a drawing, and bending the end into a hook that will catch a chicken's leg. A second wire attached to the handle and twisted about the first will add strength.

Coal to Our Rescue

(Continued from page 113)

form such simple molecules as carbon monoxide, hydrogen, and acetylene. Only after these preliminary processes do we turn around and rebuild our basic molecules into more complex forms to make everything from ammonia to plastics. Recently a lot of research has gone into the study of ways of deriving products from coal by a still shorter route.

The U. S. Bureau of Mines, following German and British experience but going beyond this, has set up a test hydrogenation plant capable of producing not only oils and gasoline, but also phenol, cresol, benzene, toluene, solvent naphtha, and a host of other major chemicals. The tar-acid yield, according to no less an authority than Secretary of the Interior Harold L. Ickes, will be increased about 10 times above the yields now obtained from the by-product coke-oven process. And these acids, the phenols, cresols, and xylenols, are vital to the growing plastics industry. Our new synthetic-rubber industry will also be able to get most of its basic materials from coal hydrogenation—or degeneration, as the chemists call it.

But we won't have to put all our hopes in the hydrogenation process. Two new processes of conversion are coming to the fore. One uses a method of heating coal at elevated temperatures in the presence of solvents such as phenol or aniline. A second new process is known as "controlled oxidation."

Workers at the Carnegie Institute of Technology have developed apparatus on a laboratory scale that needs only the coming of peace for realization on a commercial scale. In this process the coal is burned at low temperatures in a reaction very much like the energy-conversion processes of the human body. An acid solvent is used with air or oxygen under pressure to produce organic acids such as oxalic acid, acetic acid, and the other carboxylic acids. The relatively simple process converts as much as 60 percent of the weight of the coal into usable products, while carbon dioxide gas is the principal by-product.

Another new process will prove of value in the cheapening of phenolic resins, the most widely used of plastics. This method, developed by M. W. Kiebler, of the Coal Research Laboratory, involves the treatment of coal with hydrogen under high pressure. It differs from more expensive German procedures in that caustic soda is first used on the coal to remove oxygen, thus greatly reducing the amount of hydrogen needed. This trick is accomplished in an ingenious reaction vessel in which a motor, used to agitate the products, is enclosed in a bomb under working pressures of 6,000 pounds per square inch. Water is used to cool the motor, for the reaction temperature is 840 degrees F. Only one sixth of the power required by conventional arrangements is needed for this installation, and thus a further cost reduction results.

Coal is the means of developing a new field in water purification. From bituminous coal, chemists now are learning how to prepare "cation exchangers," particularly useful in softening hard boiler-feed waters and acid waters. This economical process may permit the location of industrial plants requiring large quantities of water at sites which are not usable today because the only water available has an undesirable mineral content.

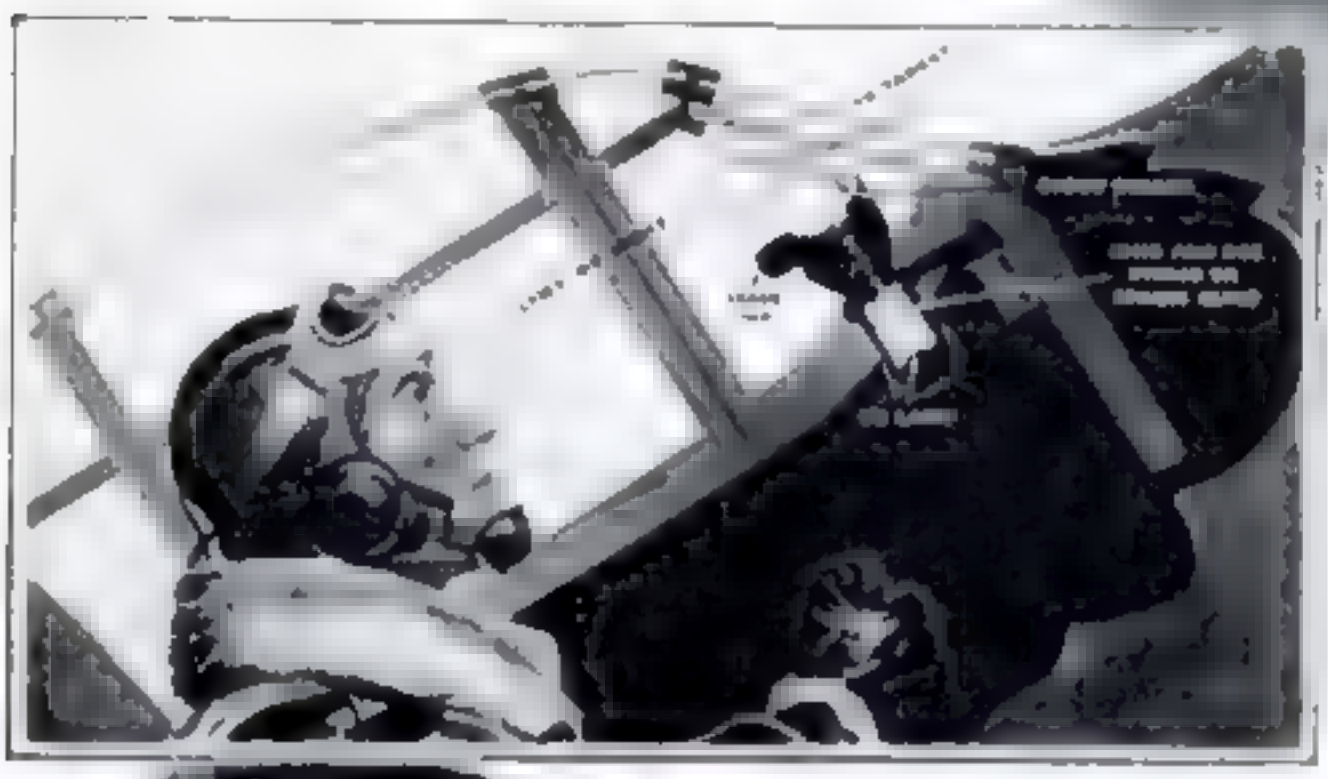
The agricultural industries have long used coal by-products to increase production. For from coal we get insecticides, fertilizers, disinfectants, herbicides, fungicides, fumigants, preservatives, and food dyes. Recently research chemists have found a way of producing synthetically from naphthalene, a coal derivative, hormones that will greatly increase the yield of scientific farming. Hormones are the regulators of plant growth. They enable fruits to grow without cross-fertilization and help cuttings to develop roots. They also help to prevent fruit from dropping off trees prematurely.

The list of new coal uses might be expanded indefinitely and, indeed, is being expanded daily in the laboratories of our government agencies and our great industrial plants. And with each expansion, be it in the form of a new mildew preventive or a mold inhibiter, or a wetting agent like one new kind that actually makes a duck sink in water, the over-all cost of coal products drops a bit as production increases, and thus still further developments come into the range of commercial practicability. Truly, then, we are entering a new coal age, and with a thousand-year supply of coal spread all over our broad land we needn't worry too much about our dwindling oil reserves.

Subscribers in the armed forces who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

The lamp that paints a bullseye on Axis planes!

1. Ever wonder how our gunners can fire accurately at 400 m.p.h.? One reason is a new kind of gunsight. Instead of straining to hold the enemy in your sights as you would with a rifle, you see a "bullseye" of orange light . . . apparently painted right on the enemy plane! Diagram below shows how it works.



2. The problem G-E had was to develop a new lamp for greatly increased brightness. Combat experience showed that the image had to be bright enough to show up against Sahara sands or bright clouds. Gunsights now are being equipped with a lamp G-E developed especially to meet these conditions.

3. To design and produce this new lamp in a hurry was a tough problem...but no tougher than many which G-E research has had to solve since Edison's first lamp. Between the big 10,000-watt airport floodlight and the tiny "grain-of-wheat" lamp used for instrument illumination are hundreds of different G-E lamps working for victory.

4. The same research that produces G-E lamps used in war is your assurance that the G-E lamps *you* use will give you the most light for your money.

Hear the General Electric radio programs: "The G-E All-Girl Orchestra," Sunday 10 p. m. EWT, NBC; "The World Today" news every weekday, 6:45 p. m. EWT, CBS.

MADE TO STAY BRIGHTER LONGER

G-E MAZDA LAMPS

GENERAL ELECTRIC

THE BEST INVESTMENT IN THE WORLD IS IN THIS COUNTRY'S FUTURE...BUY WAR BONDS

Fighter-Plane Firepower

(Continued from page 83)

to bring down 72 German transport planes without a single machine-gun stoppage. Its hitting power is just as remarkable—four Wildcats armed with Brownings have sunk two Jap destroyers.

Another important factor is the comparative weights of the guns. The 61-pound Browning weighs about half as much as the Hispano. In a minute, while one Hispano fires 700 shots weighing 203 pounds, two Brownings can fire a total of 1,700 shots weighing 172 pounds. The Hispano has the advantage in weight of fire, but the two Brownings fire more projectiles—important against fast-moving targets. Since the Brownings' ammunition is lighter, a fighter can carry more rounds, and so has a longer duration of fire.

The German Mauser 15-mm. (.59 caliber) is an excellent gun, throwing heavier bullets than the Browning, but having a lower rate of fire and less muzzle velocity. The Mauser 13-mm. (.51 caliber) is also good, but like other Nazi weapons, its involved design is not suited to mass production.

Airmen predict that in future air-to-air fighting, precision shooting will be made less essential by the use of high-explosive shells, set with time fuses, and capable of destruction over a large area.

Typical armament of present leading fighters is shown in the tables and illustrations on pages 78 to 81, but it must be remembered that armament combinations constantly vary according to the objective.

The fighter with the heaviest weight of fire is our Army P-51 Mustang, armed with four 20-mm. Hispano-type automatic cannon. In the same class are the British Spitfire IX, Hurricane IIC, and Typhoon. Just as bad medicine is our Army P-47 Thunderbolt, armed with eight .50 caliber Brownings. The Army P-40F Warhawk and the new-type Mustang—said to be the fastest plane in the world—carry six Brownings. The most diversified armament of any fighter plane is carried by our Army P-39 Airacobra—two .50 caliber and four .30 caliber machine guns, and a 37-mm. cannon. The Army P-38 Lightning packs a heavier punch, with four .50 caliber Brownings and one 20-mm. cannon. The hardest-hitting Nazi fighter is the new 109G Messerschmitt, said to carry five guns. Various combinations arm the ME-109F and Focke-Wulf 90. Jap Zero fighters usually carry one 20-mm. Oerlikon and four 7.9-mm. machine guns. None of these planes, however, matches ours in firepower.

There's Been a Big Change

Almost any old-timer will give battle if you question the advantages of living in the old days. But few will deny that change in the *mechanical* world was inevitable, and good.

Take tapered roller bearings. Tyson found the way to add more rollers around the raceway—developed a heavy-duty bearing which solved many an industrial and transportation problem.

Actually, a Tyson "All-Rolls" Bearing has *thirty percent more rollers*, on the average, size for size. Obviously, this means greatly increased load capacity. Many users say bearing life is doubled.

You can depend on it—Tyson is the most advanced, strongest, longest-lived bearing ever built.

The big name in bearings today is . . . **TYSON!**

TYSON BEARING CORPORATION, MASSILLON, OHIO

COUNT THE ROLLS · THE ROLLS COUNT

Tyson

TODAY'S HEAVY-DUTY BEARING

★ BUY MORE WAR BONDS ★

Superspeed Mapping

(Continued from page 72)

of every peak in a mountain range without getting out of their comfortable chairs . . . can even scan 150 miles of escarpment or follow a river to its headwaters and never leave their desks. They sit in the seats of the gods and make charts for men who consort with the stars.

The first step in converting photographs into charts goes right back to the first step in the field work. Geodetic control points must be found and identified. Field-party notes show, for instance, that point 6 is the junction of two rivers at a given latitude and longitude. The index map shows this point to be on vertical photograph 74, and also to appear on 73 and 75. Field notes give the direction of each river's course, angle of junction, and bearing of three near-by mountains.

The laboratory man puts pictures 73 and 74 under his stereoscope and in five minutes can explore hundreds of square miles of country through which the field parties labored painfully for days. He finds the river junction and identifying mountains, verifies the river courses, and checks what he can see against what the field party reported. Satisfied at last, he marks the geodetic point with a circle inscribed in a triangle and similarly marks the same point on every photograph where it appears.

Now the technician figuratively steps into the mapping plane. He must learn the exact position of the plane and its direction of flight when each picture was taken. Updrafts tilt the plane. Cross winds cause drift. He calculates these factors mathematically from the relative position of natural features in consecutive vertical pictures and comparative horizon lines in the oblique pictures. Azimuth lines, true direction of flight, and plumb points—precise verticals dropped from the camera's position—are indicated on the picture.

Information is now in hand to begin transferring detail from the photographs to the map base. The first step is the charting of key points by triangulation on the rectoblique plotter, an instrument for determining true horizontal angles from an oblique photograph.

An oblique photograph is squared on the plotter with a pivot pin at its plumb point. Alongside is fastened a transparent paper template to which are transferred the photograph's azimuth lines. A master pointer, which swings on the pivot pin, is moved to each detail point on the photograph, and a

(Continued on page 192)

EVINRUDES ON THE HOME FRONT *help battle an enemy deadly as the Japs!*

TREACHEROUS enemy of all mankind is the malaria-bearing *Anopheles* mosquito . . . dreaded alike in New Guinea's jungles and fox holes, and in many a sector of the home front.

Along the placid back waters of Tennessee Valley's vast man-made lakes, the battle against *Anopheles* goes on endlessly. The war-busy population of this new industrial "Ruhr of America" must be protected from the ravages of malaria . . . and the Tennessee Valley Authority has energetically fought the *Anopheles* wherever it breeds!

Fleets of spray boats propelled by outboard motors are a strategic and highly effective weapon in this vital work. Outboards drive these boats from bases to "battle grounds". Outboards speed the inspectors on their rounds, and are useful in many other phases of Malarial Control Operations.

Throughout America, in countless unspectacular but essential services, peacetime Evinrudes are handling their jobs quietly and efficiently. Today Evinrudes are being produced exclusively to meet the specialized requirements of our fighting forces. After Victory there will again be Evinrudes for all . . . brilliant new Evinrudes packed with performance to surpass the finest you've known before!

EVINRUDE MOTORS, *Milwaukee, Wisconsin*

Evinrude Motors of Canada, Peterboro, Canada

★HELP SPEED VICTORY . . . BUY MORE WAR BONDS

"and now...Good Luck and Good Hunting"

This is the day I've looked forward to since I was seventeen . . . this is the day I win my wings.

Mom and Dad are waiting there. Dad's standing tense and straight and tall, and his face looks proud and grim, as though the General were talking to *him*.

"...they tell me you're hot pilots and navigators and bombardiers. And it is well you are..."

As we marched in, Mom waved and I caught the white flutter of her handkerchief out of the corner of my eye. In a moment or two she's going to cry—just a little—like she did the night we talked it all out, she and Dad and I, when I told them I wanted to fly.

"... to your families, I say—ours is the safest military flying of any of the world's air forces."

And now here on the parade grounds, with the shadows falling and the bright flag whipping in the sky, I remember Dad said, "Son, your Mother and I won't stand in your way. If this is what you want to do—do it with all your heart and soul and God be with you. I wish I were your age—so *I* could fly and fight."

"And I say to you cadets, get the enemy in your sights and let him have it . . ."

Now, in just a minute, we'll right face and walk up to the platform under the flag. And the General will hand me the parchment, and then he'll pin silver wings on my blouse and return my proud salute.

"The world has never before seen a team like the Army Air Forces . . ."

Thinking of all the days and nights packed with hard work . . . our college training . . . the numberless flights with patient instructors . . . the painstaking way we were taught to fly safely on instruments, how, flying wing tip to wing tip, we were brought together closer than brothers . . . I understand what our General means. The Army Air Forces are more than planes, more than men, more than machines—a *great team* with one aim, one object, one goal.

"... to sweep the skies clear, so free men may walk with their heads up and without fear . . ."

And as the last man receives his wings and the gun booms out and we stand retreat and the flag comes slowly down, I'll thank God *my* father and mother gave me the chance to win my wings . . . belong to the greatest group who ever fought or flew . . . gave me a future and a career!

"And now, gentlemen, we have work to do—and I leave you . . . good luck—and good hunting."

If You are 17 . . . Go to your nearest Aviation Cadet Examining Board today . . . if you can qualify for the Air Corps Enlisted Reserve, you will receive Enlisted Reserve insignia but will not be called for training until you are 18 or over.

When called, you'll be given 5 months' training (after a brief conditioning period) in one of America's finest colleges . . . then go on to eight months of full flight training. When you graduate as a Bombardier, Navigator or Pilot—you will receive an extra $250 uniform allowance and your pay will be $246 to $327 per month.

Meanwhile. . . you should see your local Civil Air Patrol officers about taking C. A. P. Cadet Training—also your High School principal or adviser about the recommended courses of the Air Service Division of the U. S. Victory Corps. Both will afford you valuable pre-aviation training.

(Essential workers in War Industry or Agriculture—do not apply)

U. S. ARMY RECRUITING SERVICE

"Nothing'll Stop the Army Air Corps"

"KEEP 'EM FLYING!"

For information regarding Naval Aviation Cadet Training, apply at any Naval Aviation Cadet Selection Board or any Naval Recruiting Station; or, if you are in the Navy, Marine Corps or Coast Guard, apply through your commanding officer . . . This advertisement has the approval of the Joint Army Navy Personnel Board.

Superspeed Mapping

(Continued from page 188)

toggle moves a straightedge on the template to a corresponding angle. By drawing lines along the straightedge, the operator constructs a series of radiating rays—triangulation lines—which are numbered according to the photograph's detail-point numbers. Assemble a sequence of paper templates, and these detail points will be located at the intersections of similarly numbered lines.

To transfer this information to the huge sheet of cellulose acetate which becomes the map base, still another short cut is used. A metal template is made for each paper template by assembling slotted spring-steel strips around a hub corresponding to the paper template's plumb point. When these metal templates are mounted in order on the acetate sheet, the intersecting rays are connected by studs which allow adjustment of the whole layout. Now the triangulation has become mechanical, and when the whole layout is complete, a marking pin is driven through the stud at each detail-point intersection into the map base. These pin points are marked and numbered on the map base with celluloid ink, and the metal templates are taken up.

The skeleton of the finished map is now ready to receive the details that will give it life. Key points are in place. Directions are established. Relationship of flight pictures is determined.

Meanwhile, the photographs have been studied under magnifying stereoscopes, and features to be shown on the finished map have been outlined in ink. Now the map base is cut into three-foot strips and sent, with corresponding pictures, to detail sketchers. By placing the photographs in a camera-lucida type of instrument called a "sketchmaster," the operator can project the image of the photograph onto the acetate base. Adjustments bring the image into proper scale, match its key points with those on the map, and compensate for tilt and distortion. This done, the operator draws the photographic detail on the map base.

With this detail on it, the master map is edited, checked, and labeled with known place names. After inking, it is a master transparency of a planimetric chart, showing all important surface features. Negatives can be made from it, reduced to desired scale, and emergency maps can be printed. But it still lacks contour detail and radio and aeronautical data.

For contour detail the photographs are

(Continued on page 194)

STYLED BY MASTER CRAFTSMEN

— and welting (the process of stitching the welt to the upper and innersole) is one of the vital operations in shoemaking. W. L. Douglas uses only the finest Goodyear welts, employs only expert craftsmen

IT'S DOUGLAS STYLING

that makes the difference in Good Looks—in Wear

Between the initial selection of the finest leathers available for their manufacture to the final shining-and-polishing stage, every single pair of W. L. Douglas Shoes is five times inspected by experts. Worked on by 130 pairs of skilled hands. And handled throughout with the painstaking care of the true craftsmen, who take pride in perfect work.

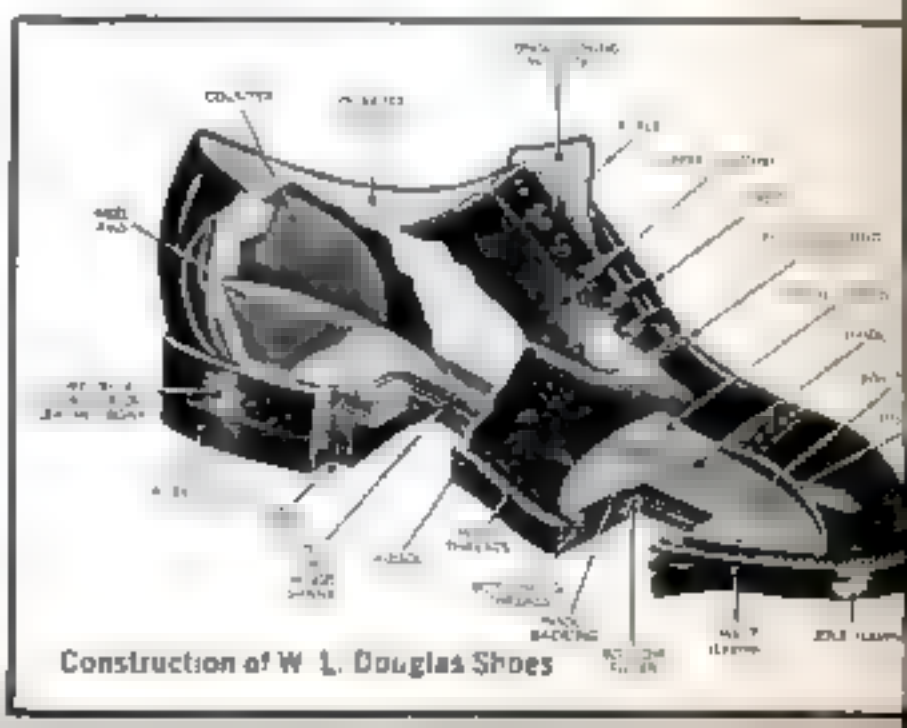
That's why you'll find W. L. Douglas good looks so completely satisfactory. Just try a pair today. Test them yourself for workmanship, smartness, comfort. You'll know, then, why men all over America are spending their ration coupons for W. L. Douglas Shoes.

$6.50 - $8.50

Some styles $5.50

Douglas "Dou-it-the-Wood" construction assures you better fit.

THE COMMANDER
A favorite of service men and civilians is this tan plain toe oxford. Rugged leather sole for all weather comfort. No. 4565 In black No. 4035

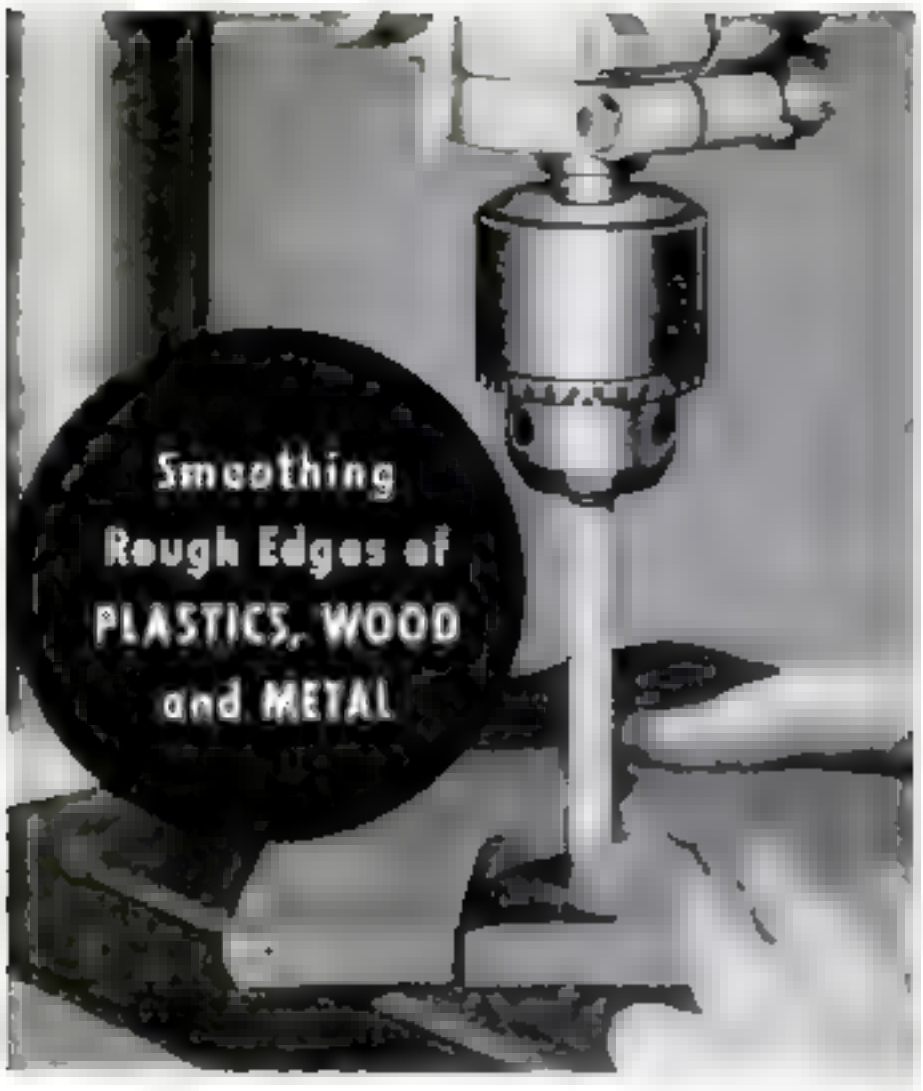


Construction of W. L. Douglas Shoes

W. L.
Douglas Shoes
W. L. DOUGLAS SHOE CO., BROCKTON 15, MASS.

Stores in Principal Cities—Good Dealers Everywhere

BUY WAR BONDS AND STAMPS FOR VICTORY



with a SANDING STICK and JACOBS CHUCK

Most of the interior cuts made with a scroll, jig, or fret saw require sanding or smoothing to remove irregularities. Round and half-round files and sanding sticks have been used by hand for this work, but the hand method is slow and tedious. Using a sanding stick, as illustrated, speeds up this work immeasurably and improves the quality.

Sanding sticks are easily made up in any shop. With the drill press supplying the power, both hands are free to guide the work.

To Get The Most Out of Your Drill Press or Lathe – get this New Book

The operation outlined briefly here is one of nineteen covered in detail in our new booklet just off the press. Printed in color and containing 49 illustrations, it shows how the set-ups are made, illustrates the tools used, and in some instances tells you how to make the tools themselves. If you have a workshop you will want the valuable ideas this book contains. If you are planning a shop of your own for after-the-war, you will want the booklet now to help you plan.

Superspeed Mapping

(Continued from page 192)

checked through another specialty instrument, the photoalidade—a small, high-precision telescope mounted on trunnions and calibrated for vertical angles. With it an operator can, in effect, sit almost four miles above the earth and vertically triangulate any point shown on the oblique photograph in front of him. The data he provides is transferred to the chart, and final proofs are made. Separate sheets are inked for each contour tint, for drainage, for culture features, and for the latest radio and aeronautical data. From these sheets, full-color charts can be printed.

Tri-metrogon charts are primarily for aerial use, although they have been used by ground reconnaissance forces. Ground engineers are sometimes critical, saying they may deviate two or three hundred yards in their accuracy. Airmen say such criticism is captious because these charts replace maps on which mountains and rivers often are shown many miles out of position—if they are shown at all.

Wartime transport demanded and tri-metrogon achieved, virtually overnight, working charts of the Far North, of South American jungles, of interior Africa, of remote Asia. Man had never even seen some of these areas from the air before.

Like much of the war transport itself and the supporting ground work, tri-metrogon charting has developed with unbelievable speed. Its very existence was unknown to the public a year ago, and its details have only recently been revealed.

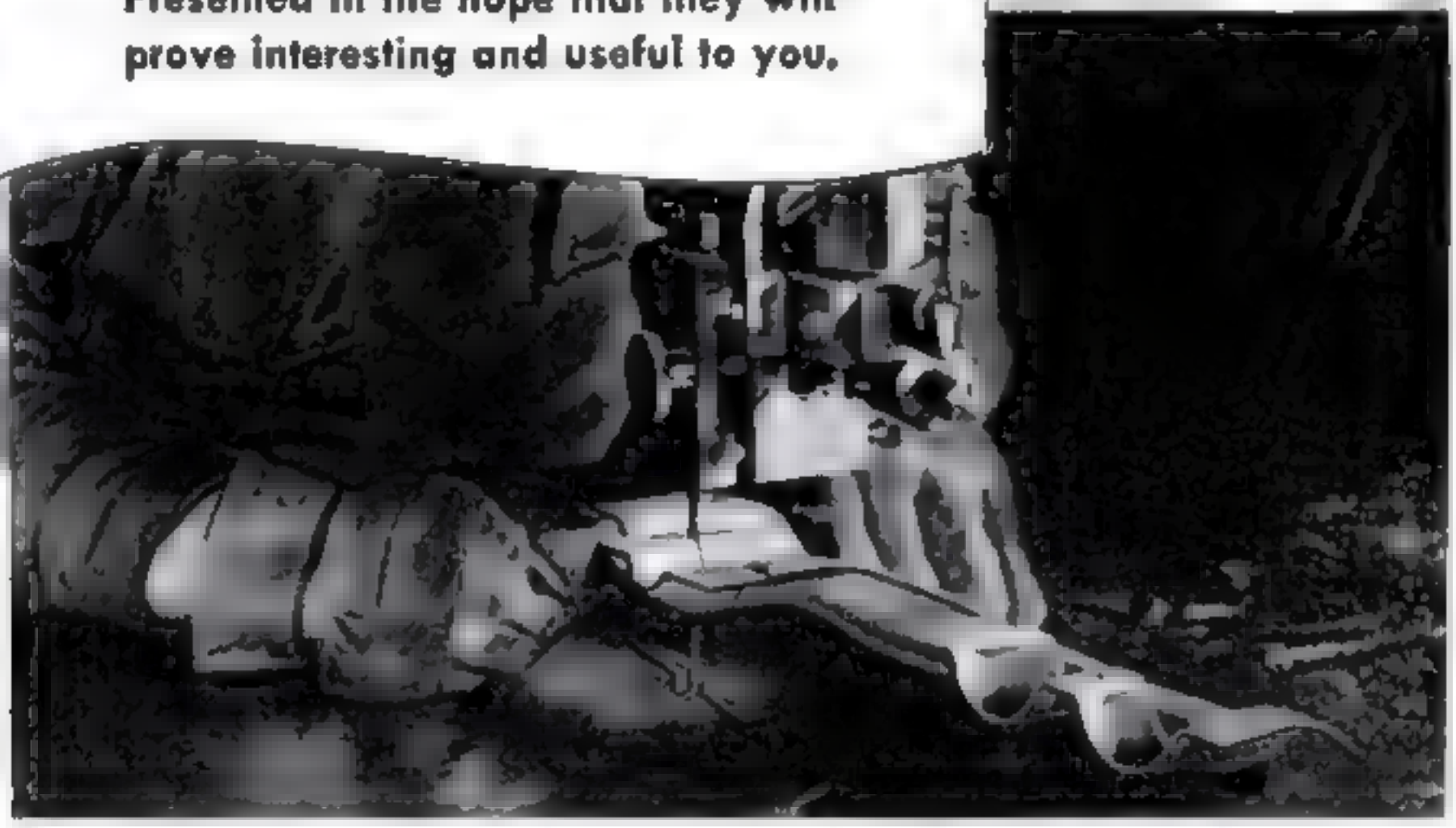
While the routes now covered by tri-metrogon charts are a military secret, it can be stated that the Army Air Forces have photographed more than 5,000,000 square miles, and its Compilation Units have translated three fifths of these photographs into maps and aeronautical charts. This tremendous task unquestionably is the largest single mapping contribution ever made; and for many years of postwar adjustments, these photographs, maps, and charts will play an important part, not only in aviation, but in the intensive development of natural resources in little-known parts of the world.

The particular function of tri-metrogon instruments and techniques, however, is to do a quick, thorough job of charting for the airman. And before the war is over, our military files will include working charts of every major air route needed, not only for war, but for the tremendously expanded Air Age that will follow.—HAL BORLAND.

Ingenious New

Technical Methods

Presented in the hope that they will prove interesting and useful to you.



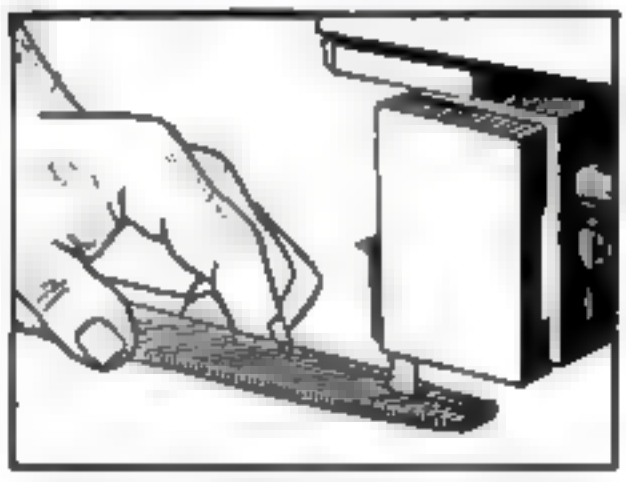
Hard Steels Cut by Heat Generated by Super High Saw Speeds

Ordinary band-saws, when operated at unbelievable high speeds up to 12,000 feet per minute, cut through hard steels and alloys by heat generated from the friction of the saw against the metal to be cut. The cutting effect is more that of burning through the metal than actual cutting. The heat generated is sufficient to melt or burn out the metal in the saw cut but not enough to draw the temper on the sides.

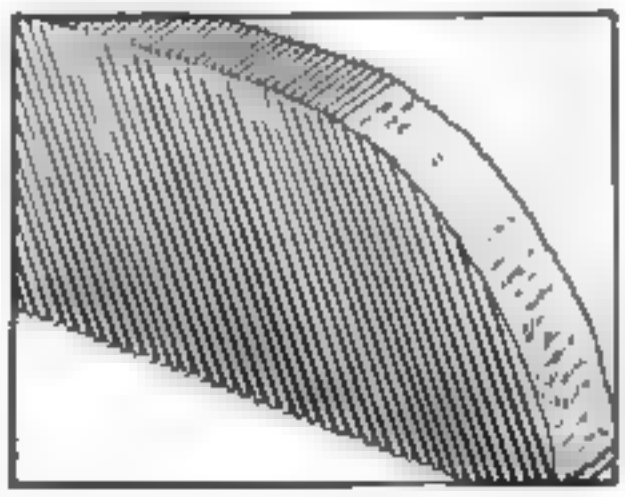
The hardness of either saw or metal to be cut is of little importance. Thin metal sheets are cut like paper, and plates up to one inch in thickness can be cut at speeds of ten inches per minute.

We hope this has proved interesting and useful to you, just as Wrigley's Spearmint Gum is proving useful to millions of people working everywhere for Victory.

You can get complete information about this method from Bell Aircraft Corporation, Buffalo, New York.



Proof of ability of new method to cut hard materials is demonstrated by operator cutting a file.



The temper of curve cut section shown above is unaffected.

X-63

DAMN THE BOTTLE-NECKS

Full Speed Ahead!

Making only Chicago Mounted Wheels and small Grinding Wheels—maintaining the highest quality—shipping orders promptly—**this is our job, our battlefield.**

With full WPB approval, we stopped making all large sizes and fixed our sights on wheels 3" in diameter and under.

We worked around the clock, 24 hours a day, and in a short time were able to fill orders on time. And, our central location cuts time in transit. Today there is no waiting. With the Army-Navy "E" at our masthead, we are going full speed ahead.

Handee Tool of 1001 Uses and **Hi-Power Grinders** are still available to all who have priorities.

Send for Free Catalog.

MERCURY MEDIUM GRADE MOUNTED WHEELS — SMALL GRINDING WHEELS

CHICAGO WHEEL & MFG. CO.
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Test-O-Lite the MODERN TROUBLE SHOOTER

THE NEON GLOW

. . . LOCATES TROUBLE INSTANTLY in electric circuits, fuses, cut-outs, motors, radios, appliances. Tests everything electrical from 100 to 550 volts. Indicates hot or grounded wires. Tells AC from DC. Far superior to ordinary clumsy test bulb.

PUTS "FINGER" ON THE TROUBLE SPOT - - QUICKLY

Saves precious time. Indispensable in shop or home. Has patented safety features. Vest pocket size with clip. Lifetime guarantee. List $1.50 (Priority A7 required) Purchase through regular electrical dealers.

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85 Paterson St. Newark, N. J.

1953: A New World

The Commencement of Divine Order

A New World is emerging from the present conflict. A New Society is being born. Do you aspire to know the standards of Citizenship, its aims and ideals, its history and achievements? 1953 marks the beginning of a different kind of world. What will it be like? How will Cultural human progress? Where will its cultural center be located? Read [illegible] IN COMPARABLE 48 pages of answers with unusual information. Free. No obligation. Write Dept. U.

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The Tool With 100 Uses

XACTOR

THE POCKET-SIZE PROTRACTOR

for Engineers-

Tool Grinders-Machinists-Tool & Die Makers

Xactor is a significant, valuable Christmas gift that will be treasured for a lifetime. This carefully machined, true precision tool, made of the best grade of materials, measures angles to an accuracy of ½° of 1'. Vernier equipped, the adjustable sliding arm pivots the full 360°, assuring accurate measurement of any angle instantly.

Xactor graduations are deeply etched for easy reading, even in poorly lighted shops. Size 6" x 2¾ x ⅛ 16".

Xactor is indispensable for every Engineer, Tool Grinder, Machinist and Tool and Die Maker as it saves time and eliminates errors in checking and laying out work. A gift that will be gladly received - and one you'll be proud to give. **Certification with priority of AA1X or higher required from employer**

Xactor

Measures Angles of: Drill Points, Tool Bits, Machine Ways, Parts, etc.

Xactor comes in neat leather vest-pocket case—packed in box. ORDER NOW to Have for Xmas. ONLY $10.25 Plus Postage

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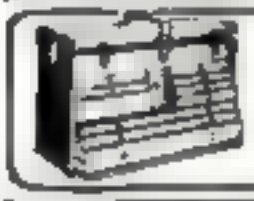
Are you a collector? A game and rumpus room decorator? Your treasure hunt ends in our catalog listing over 1000 authentic items including old pistols, swords, knives, armor, etc. To get your 100-page illustrated catalog send 25c to **ROBERT ABELS, BOX PS, 360 Lexington Ave., New York 21, N. Y.**



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PROTECTION FROM RUST
TOOLS—GUNS—LOCKS, TACKLE, ETC.

For years [illegible] have used Fiendoil to keep their guns [illegible] free from rust. Fiendoil actually offers [illegible] metal surfaces. At Your Sports or Hardware Store. In 3oz. 8oz. Bottle

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LEPAGE'S GLUE

LEPAGE'S MODEL AEROPLANE GLUE
LEPAGE'S LIQUID SOLDER

The Seabees Can Do It

(Continued from page 57)

smashed, the controls shot away. To anyone but a Seabee it was not worth scrap iron. A repair shop in the States would have asked two weeks to do the job, yet the Seabees had the shovel rebuilt and operating in two days.

Getting the most out of equipment is a Seabee hobby. On one spot near a Japanese air base, the Seabees built an airfield in record time. Carrying surfacing six miles to the runways, the dump trucks averaged 250 miles per day. Spark plugs were cleaned with blowtorches; air compressors were kept running 23 hours per day, and steam shovels, draglines, and caterpillars worked around the clock. The runway, 6,000 feet long, built across the island with a 16-foot cut through a granite ledge, was finished in 28 days. Ack-ack kept the Japanese dive bombers away until the job was done.

When Seabees were sent to Trinidad their equipment had to be shipped five times, on account of submarines, before it finally arrived. Private contractors were stymied; they said it would take 77 days to finish a job. The Seabees waded in, used their own material, and had the barracks and other buildings up in 27 days. In addition, they completed other unfinished jobs and, for good measure, built themselves a complete theater with stage settings, scenery, and "Earl Carroll" fittings. In another area, when refrigeration units failed to arrive, they improvised two Quonset huts into coolers and saved a huge shipment of fresh meat from spoiling.

Prior to America's entrance into the war, naval bases and other outpost defenses all over the world were being built, under the preparedness and lend-lease programs, by civilian contractors and technicians, and construction gangs composed of American skilled mechanics, electricians, carpenters, welders, plumbers, painters, masons, and engineers. As civilians, however, the workers were often hard to control, and after Pearl Harbor military authorities organized them into a new enlisted arm of Uncle Sam's defense forces.

Credit for the formation of these Construction Battalions, which are commanded by officers of the Navy Civil Engineer Corps, goes to Rear Admiral Moreell. The first regiment was authorized in December, 1941. In a three-week training schedule the recruits absorbed as much military knowledge as could be crammed into them between 6 a.m. and 9:30 p.m. by Marine top sergeants and Navy bosuns' mates and quarter-

(Continued on page 200)

TOUGH...BUT OH SO GENTLE

PROTECT YOUR PRECIOUS MOTOR

● Your automobile motor is precious. It must be watched, protected—its long life insured.

Watch the piston rings, especially. At the first sign of ring failure, install new rings—to serve oil and gasoline, and to check cylinder wear.

If you have not seen your motor service man recently, you should do so immediately. He will set up a *Protection Program*, step by step. He will tell you which symptoms are dangerous, and recommend the remedy.

By this method you can insure the long and economical operation of your precious motor.

HASTINGS MANUFACTURING COMPANY HASTINGS, MICH.
Hastings Mfg. of Canada, Ltd., Toronto

It's a privilege to buy War Bonds

HASTINGS

STEEL-VENT PISTON RINGS

Tough on oil-pumping · Gentle on cylinder walls

The Seabees Can Do It

(Continued from page 198)

masters. When the grind was over, they could handle all types of weapons from hand grenades to machine guns. Their job was to build—and having built, to be able to defend. They were ready for anything—salvaging ships or building airfields, sea ramps, docks, camps, jungle trails, and bridges, often doing it under fire and always doing it in a hell of a hurry.

The Seabees represent 60 different skilled trades. The poorest-paid Seabee gets $54 monthly for home service, and $64.80 overseas. A petty officer gets $126 monthly at home and $161 abroad. Fifty percent of the recruits are proving physically acceptable, and training at the $20,000,000 Camp Endicott, in Rhode Island, does the rest.

Today the scrappy yellow-and-blue Seabee emblem—a bee with a spitting machine gun, a wrench, and a hammer clutched in its feet—is found wherever soldiers, sailors, and Marines are fighting. When the combat troops return home, Seabees will still be on the job, salvaging, building, and repairing the ravages of war. Where today they are building to win the war, tomorrow they will be building to win the peace.

Letters About Auto Ailments Win Readers Cash Prizes

ALMOST every conceivable auto ailment from gremlins in the generator to mice on the motor was represented among the scores of entries submitted by readers in our recent contest on unique car troubles. Many of the letters revealed a skill at deductive trouble-shooting worthy of Gus Wilson at his keenest. Here is the list of the winners and their awards.

FIRST PRIZE, $50

Claude W. LaRue, Chicago, Illinois

SECOND PRIZE, $25

Clifford Younger, Glendale, California

Third to seventh prizes, $10 apiece: Carl Wildey, Crown Point, Ind.; Norman Locher, Van Nuys, Calif.; Lester Standley, Nichols, Conn.; Otto Gruenberger, Milwaukee, Wis.; and Thomas A. Faulkner, St. Paris, Ohio. Eighth to seventeenth prizes, $5 apiece: D. G. Linton, Toronto, Can.; Lieut. William W. Nivin, Camp Davis, N. C.; Horton Hicks, Opheim, Mont.; Eugene G. Glick, Akron, Ohio; Frank J. Meinen, Chippewa Falls, Wis.; Richard S. Bennion, Minneapolis, Minn.; Henry Clark, Jamaica, N. Y.; J. W. Grosdidier, San Diego, Calif.; Lynn C. Watson, Birmingham, Ala.; and Raymond A. Klemmer, Twisp, Wash.

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For All Hard of Hearing — their Friends and Families

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READY TO WEAR

COMPLETE
—WITH RADIONIC TUBES
—CRYSTAL MICROPHONE
AND BATTERIES
. . . Liberal Guarantee

★

TO PHYSICIANS: A detailed scientific description will be sent upon request. Further technical details will appear in medical journals.

★

There are cases in which deficient hearing is caused by a progressive disease and any hearing aid may do harm by giving a false sense of security. Therefore we recommend that you consult your otologist or ear doctor to make sure that your hearing deficiency is the type that can be benefited by the use of a hearing aid.

★

The Zenith Hearing Aid can be supplied only by your Zenith franchised Optician or Optometrist (no home calls or solicitations).

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CHICAGO

OFFICE OF
E. F. McDONALD, JR.
PRESIDENT

To: Manpower Authorities, Employers, Physicians,
Parents, Teachers and Hard of Hearing

Our country's manpower crisis calls for everyone's maximum efficiency. Since I lost the hearing of one ear in an accident twenty years ago I have been acutely conscious of the handicaps of the hard of hearing. While pioneering in radio I have for some years directed Zenith's research toward development of the best wearable hearing aid that science could produce.

My own company has spent millions, the radio industry tens of millions for research. This research has been paid for by scores of millions of purchasers of radio sets.

[redacted] with this technical knowledge and engineering skill now bring to the hard of hearing a new precision aid — the ZENITH RADIONIC — an instrument of the highest quality.

A hearing aid is essentially a part of a radio receiver. It wires the human body for sound. It is composed of a crystal microphone and parts of a radio receiver set reduced to miniature size and manufactured with watch-like precision. For many years it has seemed to me incredible that the public could buy a complete radio receiver for $29 or less with which they could hear the words whispered in Europe, Asia, or South America, but people with deficient hearing have paid $100 to $200 for a comparably good hearing aid to hear the human voice across the room.

Zenith's facilities and methods for precision mass production of radio sets, Radionic devices, etc., enable it to bring this superb hearing aid within the reach of all.

Eye-glasses, like hearing aids today, were once the luxury of the few. What the optical companies have done to make the finest spectacles available to everybody at low cost, Zenith is now prepared to do for the hard of hearing — to bring with the aid of modern radionic science a highly perfected hearing aid within the reach of the masses.

ZENITH RADIONIC — low cost battery upkeep wearable hearing aid — complete with miniature radio tubes, crystal microphone and batteries — will sell for $40 — about one-quarter of the price of the better vacuum tube instruments of today. Hereafter no one, child or adult, need be without a hearing aid because it is too high-priced. There are ten million people, of whom over three million are children in our schools, who are hard of hearing.

Even if Zenith never makes a dollar at this low price, it is willing to take its pay in the good will of the hard of hearing, their families and their friends. Thus begins a revolution in hearing aids — a revolution to "lower the cost of hearing" within the reach of all.

E. F. McDonald, Jr.

President,
Zenith Radio Corporation

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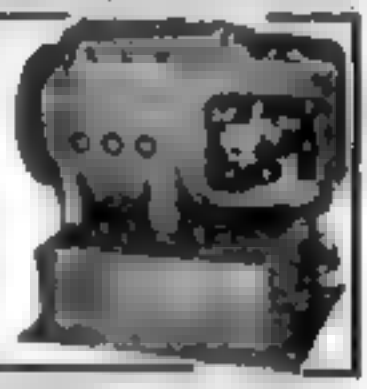

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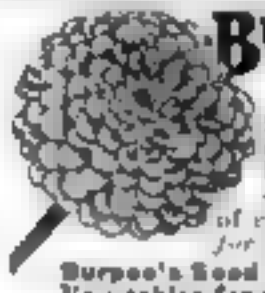

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Germany's "Fortress Europe"

(Continued from page 53)

they set in uniform rows; they pock the hills and stud the woodlands, four deep here, 10 deep a mile away. Scattered about them are rifle pits, machine-gun nests, and mortar emplacements. And, ever and always, there is the mobile artillery.

Beyond the first line is another span of open country whose every stream bank, hillside, and wooded knoll spouts death, for here again the mobile defense has taken a stand. Here, too, the tank battalions get in their body blows.

And now comes the second line, which is an even heavier edition of the first. There are more and stronger tank barriers. More tank traps. More emplacements and heavier guns. More blockhouses, more bunkers. And still heavier artillery. The path through the second line will have to be blasted virtually a yard at a time.

Again that deceptive open country. And, finally the third and last line.

Here are the massive emplacements, the many-storied individual fortresses, the heaviest artillery, the final word in tank traps and barriers. No shallow ditches here, that merely delay tanks; instead, there are man-made canyons, some of them a hundred yards across, some filled with water like medieval moats, others fitted with nozzles which can cover their floors with flaming oil.

And here are mine fields, building up from the small Tellers to supercharges which can rip the earth like heavy artillery fire. On the heights are massed antiaircraft weapons which can be lowered to deliver awesome waves of devastating fire at ground level. Here, no doubt, are the rocket guns with which the Nazis, like all the other belligerents, have been experimenting—weapons capable of great mobility and frightful destruction.

Place this third line on the defensive side of a river and you have a position that must be hammered into dust before the invaders can get through. And remember that the lines of the Inner Fortress follow the rivers. Along these river valleys are rail lines on which the heaviest weapons of mobile defense can be quickly moved. Some of those lines lead directly into the minor fortresses; some lie just behind, where the big guns can pour their fire over embankments and onto the invader. These big guns include weapons that recall the Big Berthas of World War I. Such guns have been captured on the Russian front.

At this point the attackers may face

(Continued on page 206)

Germany's "Fortress Europe"

(Continued from page 204)

gas—the weapon of ultimate desperation. The invaders, however, will not only have defenses against it; they will be able to return it, and with compound interest.

There will be cities along the way, perhaps in the Fortress line itself; and in today's war the city is a strong point, even a key defense position. The Russians proved that even a city battered to rubble is still not a city captured. In these cities there will be blockhouses and casemates commanding all approaches. Under the streets will be a maze of tunnels and areaways, and set in the pavements will be turtleback turrets with heavy guns. In the lower floors of many buildings will be bunkers, walled with steel and concrete. The buildings may be blown to bits, but the bunkers will still stand, reinforced rather than weakened by the mountains of rubble around them.

This, then, is the path to victory—a road leading from the beaches to and through the fortifications and into the Inner Fortress. Every bombing of Germany's industrial and munitions centers softens it to some degree, for no fortress stands independent of the men and materials behind it. When the big "push" comes, the Fortress walls themselves will quiver under our air attack. But the final, victorious attack must be made on the ground. A road must be blasted and hacked through the enemy's jungle of guns, tanks, and blockhouses, and fighting men must go in and conquer. How it will be done is another story that cannot be told until the Fortress falls. But we do know the magnitude of the job, and we know that it can be done, and will be done.

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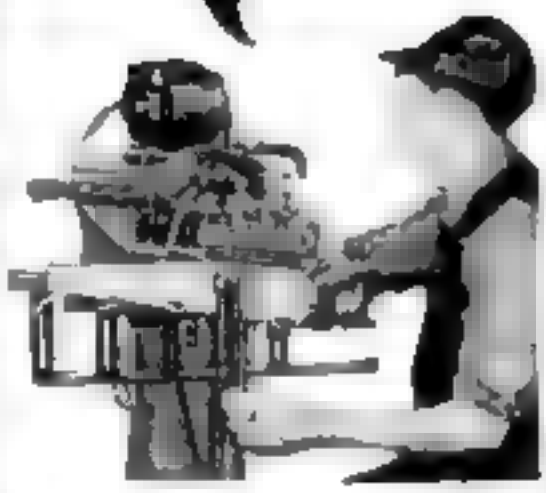

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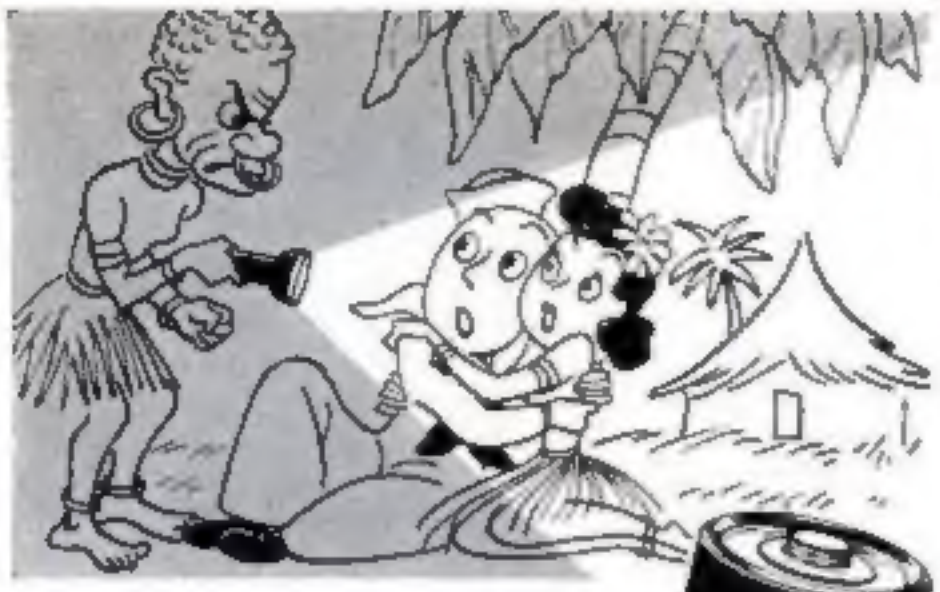

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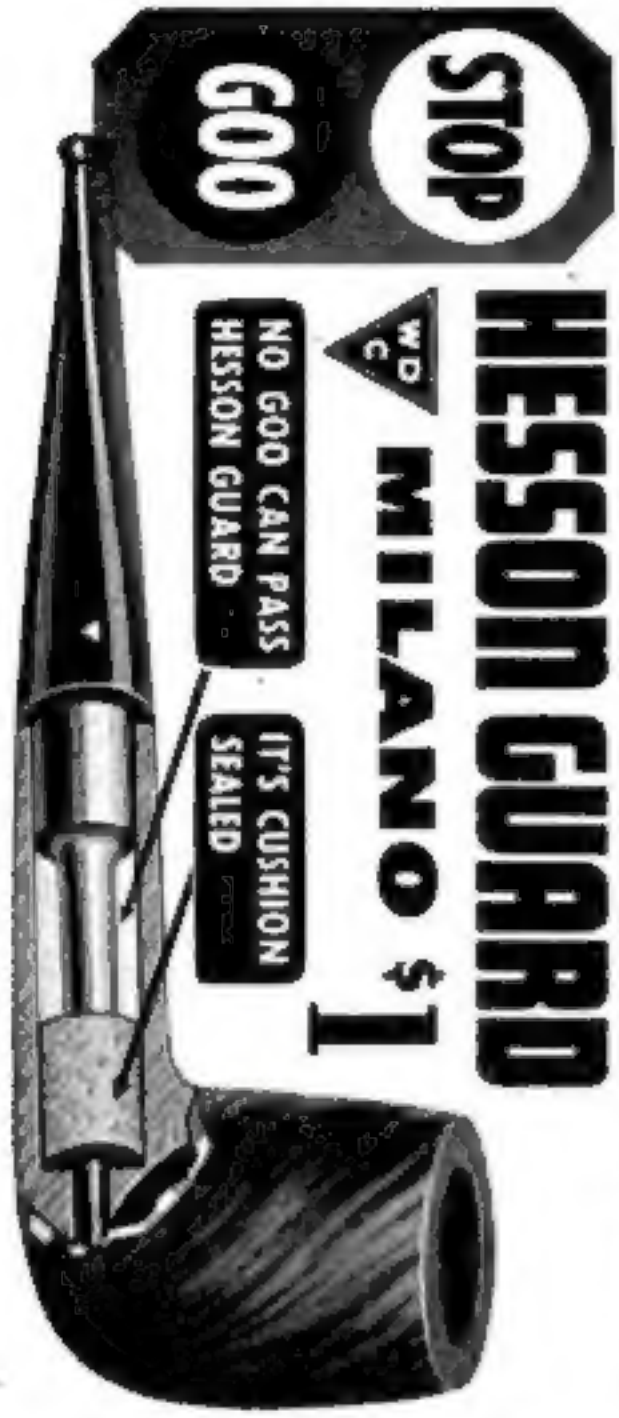

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